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Some Observations of the Absorption and Excretion of Bunamiodyl (Orabilex®) in Man[1]

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INTRODUCTION

Quantitative data on the absorption, concentration and excretion of the commonly used oral cholecystographic materials have been difficult to elucidate prior to the initiation of isotope tagging procedures. Such data in humans may prove to be of value in the comparative assessment of these contrast materials. (1, 2, 3, 4) This study was undertaken in an attempt to delienate these processes in a limited study of radioiodine tagged Bunamiodyl [3(3-butyrylamino-2,4,6-tri-iodophenyl)-2-ethyl sodium acrylate] (Orabilex®).[2]

The study consisted of seven patients, three negro males, three white males and one white female whose liver function studies had shown no abnormality and who did not have any clinical history of gallbladder disease, intestinal absorptive difficulties, thyroid disease, or renal disease.

METHOD

The patients were fasted for at least eight hours prior to the administration of the radioactive material in the early morning. Radioiodine tagged Orabilex, prepared by Tracerlab laboratories, was administered in two capsules in amounts varying from 35 to 94 microcuries. Each special capsule contained approximately 10 mg of Orabilex. These were given to the subject in combination

1. From the Department of Radiology, University of Pittsburgh, School of Medicine.
2. Orabilex supplied by E. Fougera & Co., Hicksville, N. Y.

with six non-radioactive Orabilex capsules, each containing 0.75 grams or total of 4.51 grams of Orabilex. The stomach, liver and urinary bladder areas were mapped out on scout X-ray films of the abdomen. Background counts of each of these areas, and of the thyroid and thigh were taken before giving the tagged material. The tagged capsules were counted in a thyroid phantom. All capsules were then administered individually at five-minute intervals. Blood specimens were taken at intervals and all urine was collected in individual specimens. Counting of all areas was done at various times after the administration of the tagged material. PBI^{131} conversion ratios were determined on all blood specimens by the resin column technique. An effort was made to collect all stool specimens but was not satisfactorily accomplished.

RESULTS

The results are shown in Figures 1-4. A rapid decline in the initially high counting rate over the stomach area was noted (Fig. 1). The break in the curve at approximately 3 hours is interpreted as a reflection of uptake in the left lobe of the liver, since the gastric counting included this area in each case.

It is impossible to determine from this study to what extent the disappearance of radioactivity from the gastric area represents passage into the small bowel and/or absorption through the gastric mucosa. In all cases, counts made within 30 minutes after ingestion show the presence of radioactivity in the bloodstream (Fig. 2). This activity appears to reach its peak in one to three hours and thereafter falls rapidly as it is taken up and excreted by the liver over the next five-hour period. The less rapid fall beyond this point suggests an entero-hepatic recirculation.

Almost all blood samples showed a high percentage of activity in the protein bound fraction. For example, the activity in the protein bound fraction of samples taken in one hour or less after ingestion of radioactive Orabilex varied from 60 to 100 per cent, and at the end of nine hours PBI^{131} percentages ranged from 48 to 88. The exact significance of this protein binding cannot be determined without further biochemical assay.

Figure 3 shows that the peak count over the liver was reached at approximately three hours. The break in the down slope of the curves at about eight hours was interpreted as an indication of the entero-hepatic recirculation of the tagged material and that the peak of the re-absorptive phase was reached at that time.

Figure 4 suggests that Orabilex is excreted in the urine in a linear fashion; In 20 hours 12 to 20 per cent of the administered dose was excreted and about 25 per cent was excreted in 30 hours.

External counting over the thyroid area showed a very limited uptake of radioactive Orabilex by the gland. Since the labeled Orabilex, however, represents only 0.22 per cent of the total Orabilex administered, this is a reflection of considerable uptake of the total iodine in the thyroid. I-131 uptake studies performed on patients prior to and the day following oral cholecystography

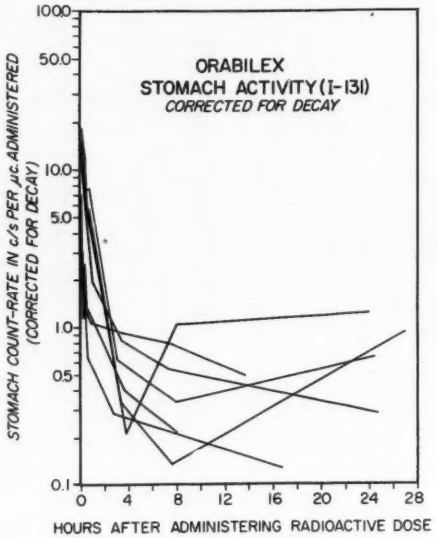

Fig. 1

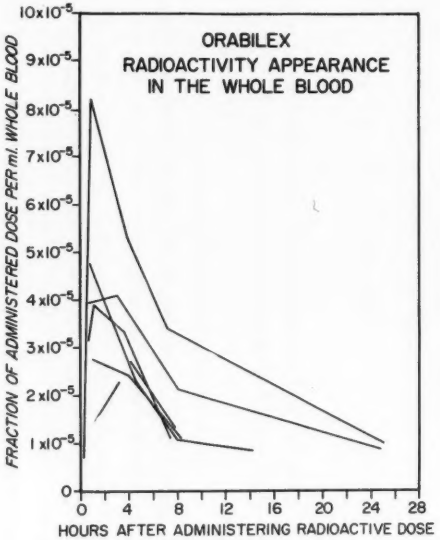

Fig. 2

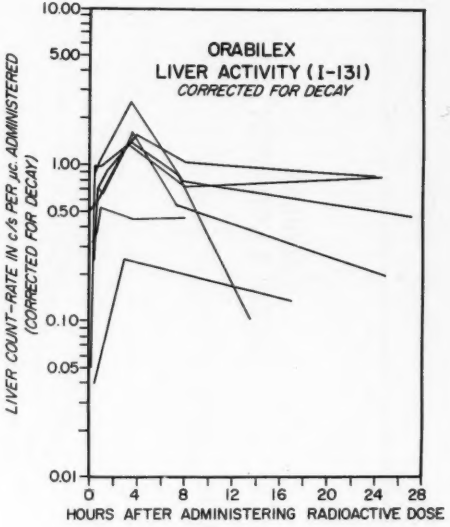

Fig. 3

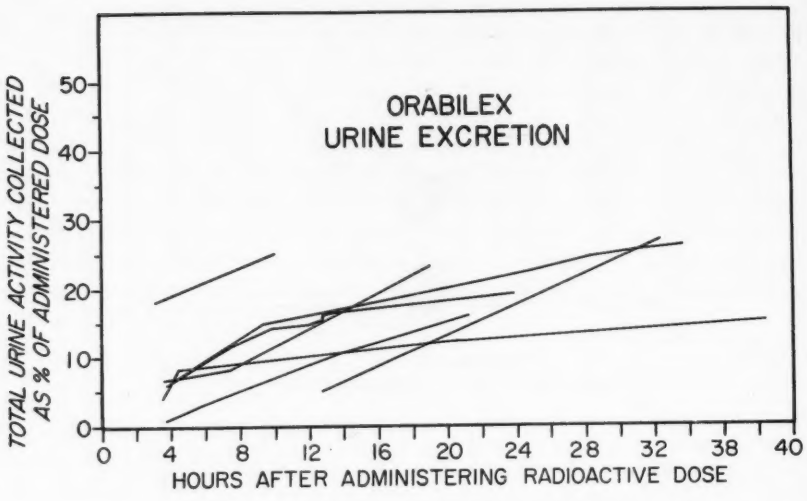

Fig. 4

with Orabilex revealed marked suppression of the post-cholecystography uptake values to ranges which would normally be considered to be hypothyroid.

SUMMARY

1. Orabilex (Bunamiodyl) tagged with I-131 has been traced through its principal metabolic pathways in seven subjects.
2. The assembled data indicate the variation of concentration of the orally administered contrast material in stomach, blood, liver and urine with respect to elapsed time.
3. Orabilex administration produced marked suppression of the thyroid uptake of radioiodine.

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A Universal Photorecording System for Radioisotope Area Scanners

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INTRODUCTION

The art of radioisotope scanning, enhanced by continuous progress over the past few years, is rapidly advancing toward the ultimate goal of recognition as a science. A steady stream of new developments provides a firm measure of the interest and general acceptance of scanning techniques. Many problems, however, continue to exist, and one of the most important concerns the recording of scan data.

No one has as yet adequately defined the criteria for a good data recording system suitable for radioisotope scanning, but most investigators would agree that the following features are highly desirable.

First, any good recording system should be capable of exhibiting very high contrast for a small change in detected activity. This is particularly important where the target non-target ratio is low. One may have the ultimate in detector sensitivity, collimation and spectrometry, but such benefits can not be realized if the resulting output data are presented with inadequate contrast. It is perhaps safe to say that other factors being equal, the one factor that determines the worth of a recording system is its contrast capabilities.

Second, any suitable recording system must be efficiently adaptable to a wide variety of scanning situations with very high and very low target non-target ratios over a wide range of counting rates.

Third, all useful scan data must be recorded. This statement should be self evident. Elaborate equipment and procedures have been devised to increase the amount of useful data, and any recording system designed to utilize only a

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portion of this available data is self defeating. Radioisotope scanning is basically a problem in statistics, and one is always interested in the best possible statistical result which, in turn, depends on the amount of data available. If possible, every information-carrying photon reaching the detector should be recorded.
Fourth, recording fidelity must be preserved. If medical diagnoses and treatment rest upon the interpretation of scans, then artifacts and distortions must be held to an absolute minimum. Inertial effects of the recording stylus and time constants of rate meters and associated circuitry can be formidable factors in this respect. Considering the various methods of scan data recording in common use, it is of interest to examine each in view of the above criteria.

Systems using mechanical styli (1) were among the first to appear and are still in use although they exhibit many serious disadvantages. These include insufficient use of data thru dot or scaling factors (number of counts required to make one mark on recording paper), poor contrast and inertial effects resulting in artifacts. As such systems are generally used for thyroid scanning, they are useful as the poor contrast is compensated, in part, by the high radioisotope concentration characteristics of the gland. When applied to other organs with less isotope concentration, their usefulness decreases. Aside from inertial effects, system fidelity related to dot factor, count rate and scan speed is generally good when such factors are optimized. The introduction of the electrical stylus in conjunction with electrosensitive Teledeltos paper (2) overcame the inertial effects of the mechanical stylus but otherwise offered no additional improvement.

A major advance was achieved with the advent of background cut off techniques employing the electrical stylus (3). For any given cut off level contrast is absolute (100 percent). All data recorded above this level has the same contrast as that of the simple electrical stylus. The main problem in background cut off systems is in knowing where to set the cut off level. The system described by MacIntyre, Christie and Crespo (4) employing simultaneous recordings at various cut off levels and multiple juxtaposed profiles, overcomes the problem of the adequate settings of the cut off levels, gives a full record of the counting rate variations within the organ studied and allows the statistical evaluation of any given area of the scan. The usefulness of the system increases with the number of cut off levels employed. Fidelity is related to dot factor, count rate, cut off circuit time constant and scan speed. Such a system has achieved excellent results in a variety of scanning situations.

The data recording system described by Maxfield (5) is capable of good results but has not yet been developed to its full potential. Contrast is achieved by varying the electrical charge in proportion to the count rate, as it is applied to a vibrating electrical stylus riding over the surface of electrosensitive paper. The resulting degree of paper blackening provides the data contrast. All data are recorded and fidelity is good, being dependent upon circuit time constant, scan speed and count rate.

Various photorecording devices have been described in the literature (6, 7, 8, 9, 10) and seem to offer the most reasonable solutions to the data recording problem in view of the previously mentioned criteria. A very wide range of

contrast is readily attainable permitting adaptability to a variety of scanning situations. The light source may take a variety of forms, i. e. incandescent lamp, flasher (glow tube) or cathode ray tube. In most cases all data are recorded. The cathode ray tube is perhaps the better choice as it can respond 10^6 times as fast as the filament of an incandescent lamp to energy changes. This is also many times faster than the ionization and deionization time required for the glow tube response. The electrical characteristics of glow tubes are also relatively unstable. Count rate, scan speed and circuit time constant are again the main factors controlling the fidelity although additional factors such as light spot size are also involved. The usefulness of photorecording is further enhanced by the application of video contrast amplification after the method of Bender and Blau (11) and offers the often desirable feature of superimposing a photorecording on to a radiograph of the scan area, thus securing the advantages of radiographic landmarks in the interpretation of the scan (12).

A graphic illustration of differences between some of the data recording systems is shown in Fig. 1. All scans were done with the same scanning mechanism under identical conditions. The only variable was the method of data recording. The scans were obtained from the phantom shown and described in Fig. 2. Figure 1-A shows a scan made with the electrical stylus on Teledeltos paper. As can be seen, little detail is apparent with the exception of the two largest cylinders. Figure 1-B shows the application of background cut off to the scan in Fig. 1-A and reveals much more detail. The cut off level is adjusted to one of many possible values and may not be optimized as to scan speed, count rate and time constant. The photorecording in Fig. 1-C was adjusted to record the full range of count rates associated with the phantom (no contrast enhancement) and shows all but the two smallest cylinders. Figure 1-D shows the application of video contrast amplification to Figure 1-C and is one of many possible settings of the contrast control of the video camera of the closed circuit television system and does reveal all objects inside the phantom. This shows that full detail is present in the full range photorecording of Fig. 1-C, but such detail is not apparent to direct vision.

The above discussion of commonly used scan data recording systems has defined the scope of the general problem in this area. In this respect the remainder of this paper will be devoted to the description and illustration of a specific photorecording system which it is felt will best satisfy the previously mentioned criteria.

DESCRIPTION OF SYSTEM

The heart of the system is a small cathode ray tube mechanically coupled to a movable scanning beam holding the scintillation detector, thus movement of the detector and cathode ray tube is synchronized. Light from the cathode ray tube screen is collimated so as to produce a round spot which is projected on to the film held in a suitable cassette. The electron beam producing light on the screen is normally off. Each radioactive disintegration detected by the scintillation probe and passed by a spectrometer causes the electron beam to be

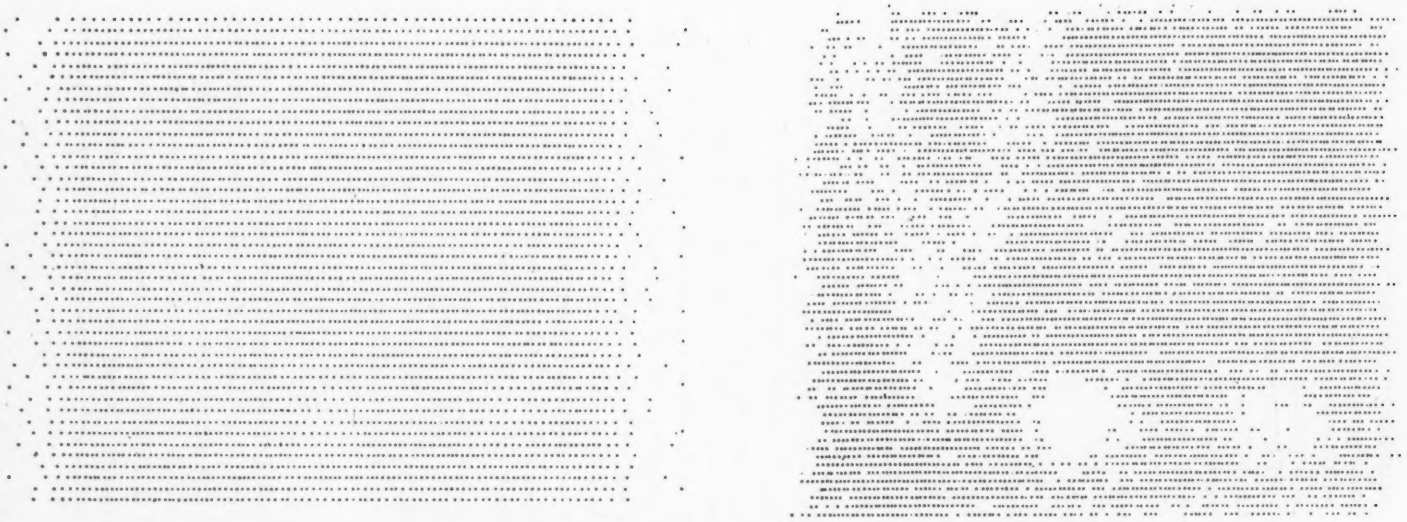

Fig. 1. (a and b) Comparison of scans made from phantom in Fig. 2. Scan (A) is a Teledeltos paper recording with the simple electrical stylus. Scan (B) is the same scan as in A with the addition of background cut off.

Fig. 1. (c and d) Scan (C) is a full range photorecording. Scan (D) is scan C with video contrast amplification.

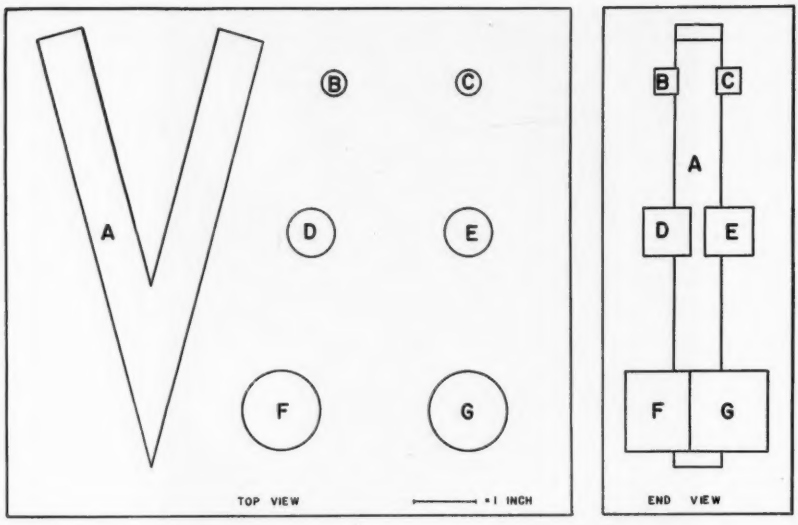

Fig. 2. Experimental phantom showing top and end views. A plastic "V" and six plastic cylinders are located at positions shown in the drawing and are mounted on vertical studs ⅛ inch in diameter (not shown). Overall dimensions are 9 × 8 × 3 inches. Diameter and height of cylinders B and C are ⅜ inch, D and E are ¾ inch, and F and G are 1¼ inch. The thickness of the "V" is ¾ inch. The remaining space inside the phantom (4 liters) is filled with water mixed with 500 μc of NaI^{131}.

flashed on for a preset length of time. Simultaneously, the average intensity of the electron beam, and thus the light flash, is varied with respect to the count rate. As the count rate increases, the light flashes are more numerous and more intense. The net result is a count-rate modulated, pulsed light system and the photoscan so obtained is the integrated effect of all the individual light pulses on the film.

At present the useful optical film density range suitable for photorecording lies between 0.3 and 2.0. The problem in photorecording is to display this change in density between some maximal and minimal count rate associated with the particular organ or system being scanned.

Referring to Fig. 3, a block diagram of the system, electrical pulses from the detector pass to the input of a spectrometer. The output of the spectrometer is applied to a rate meter and pulse driver. The rate meter, aside from the meter indication, produces a D. C. voltage proportional to the count rate over the range of 0 to 7 volts. As the count rate changes from its minimal to maximal value, the resulting proportional output voltage change modulates a high voltage power supply over a typical range of 500 to 900 volts. The output voltage of the power supply is then applied to the second anode of the cathode ray tube and thus intensity modulation of the electron beam is achieved. The

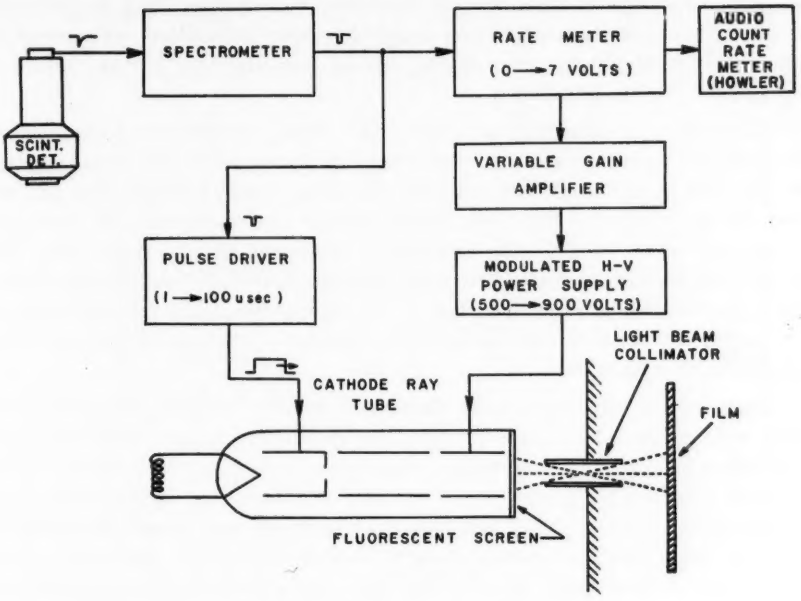

Fig. 3. Block diagram of photorecording system and associated components.

function of the variable gain amplifier is to accomodate various magnitudes of count rate change such as to always produce the 500 to 900 volt excursions at the cathode ray tube. Since a given count rate change (max.-min.) may occur at high or low count rates, provisions are also included in the variable gain amplifier for adjusting the system such that the desired 500 to 900 volt change can be referred to any count rate within the range of the system.

The pulse driver is a multivibrator type circuit producing a single positive output voltage pulse, with adjustable time duration over the range of 1 to 100 microseconds, for each input pulse. The output is applied to the control grid of the cathode ray tube to turn on the electron beam. The cathode ray tube, itself, is an RCA C73687A with a screen phosphor of extremely short persistence.

Considering system operation, for a given maximal count rate, scan speed and second anode voltage (900), a film density of 2.0 can be obtained by selecting the proper light pulse width. Assuming the minimal count rate, the same scan speed and light pulse width, one can obtain a film density of 0.3 with a lower second anode potential (500). All that is necessary then is to select the proper light pulse width consistent with the maximal count rate and scan speed, and then guarantee that the second anode voltage will be 900 when the count rate is at this value and 500 when it is at the minimal value by

properly adjusting the variable gain amplifier. The proper light pulse width for the various count rates and scan speeds has been determined experimentally and can be read directly from charts. Set up procedure for a typical scan is accomplished in 5 to 10 minutes.

The system as described has a very high degree of flexibility. Adjustments can be made such that a count rate change of 5 percent of full scale reading for any rate meter range produces the full film density change (0.3 to 2.0) or at the other extreme the same density change can occur over the full scale of any rate meter range. The rate meter employed has 7 ranges from 300 CPM to 300,000 CPM. Typical curves of Density versus Percent of Rate Meter Full Scale Reading are shown in Fig. 4. Of course, the number of such curves that could be drawn is very large. A mathematical analysis of the system is included in the appendix.

Auxiliary scanning equipment included a heavily shielded scintillation detector with a 3 inch by 2 inch crystal. Two types of focusing collimators were used, the response curves of which are shown in Fig. 5. Scan speeds were available over the range of 3 to 60 cm/min and scan line spacings over the range of 0.2 to 1.0 cm. In all tests the light spot size was ¼ inch in diameter. The rate meter has time constants of ⅛, ¼, and ½ seconds. An audio count rate meter (Howler) was found to be very useful during set-up procedures. The complete scanning system is shown in Fig. 6.

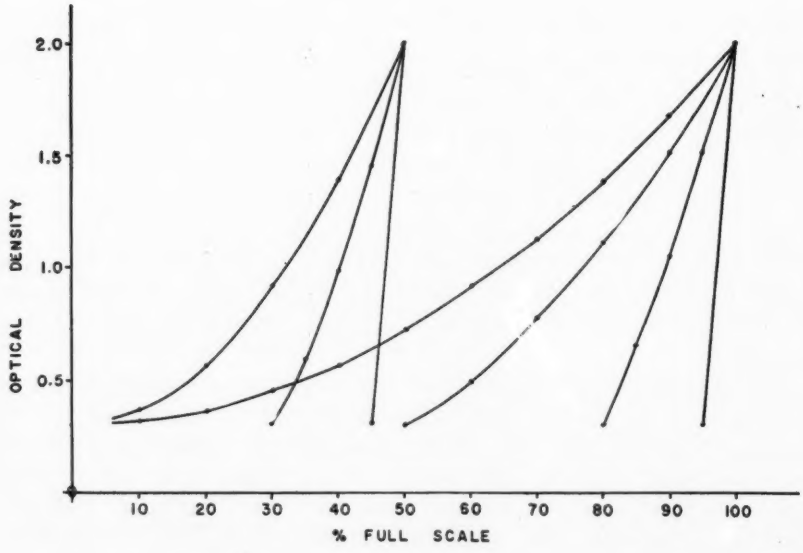

Fig. 4. Typical curves of Optical Film Density versus % of Rate Meter Full Scale Reading.

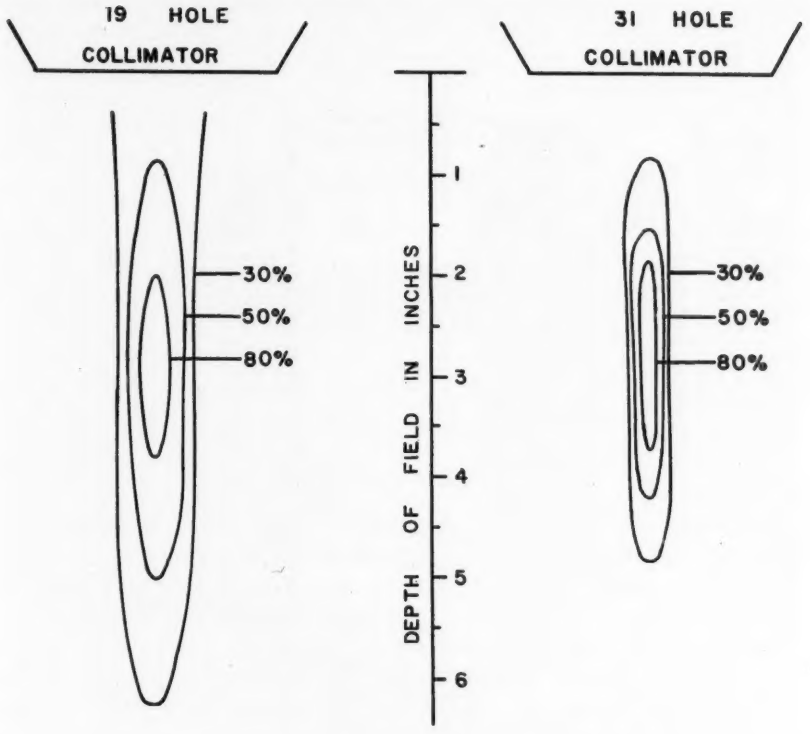

Fig. 5. Isoresponse curves in air for 19 and 31 hole collimators, using $Ba^{133}Cl_2$ (357 KEV) and 3 × 2 inch crystal.

SCANNING TECHNIQUE

Regardless of the type of scan, it is necessary to determine a maximal and minimal count rate. This was done by moving the detector over the scanning area while listening to the Howler. The count rates corresponding to the maximal and minimal pitch could then be read on the rate meter. As an example, consider liver scanning: The maximal count rate will generally occur over the area of the right lobe. In most cases, depending on the isotope, a suitable minimal count rate can be determined by placing the detector over the right lung field (general body background). The photoscan so recorded contains all possible useful information although this information would be recorded with relatively low contrast. Such a photoscan would then be an ideal candidate for video contrast amplification after the method of Bender and Blau (11).

Fig. 6. Complete scanning equipment (courtesy of Picker X-ray Corporation).

Brain scanning procedure is to scan both sides of the head. Maximal count rates will occur along a line from the angle of the eye lids to the external auditory meatus. Minimal count rates are determined in the mid-cerebral area. Brain scanning is characterized by low target non-target ratios and thus the high contrast capabilities of the system are most useful.

Thyroid scanning is similar to that of liver. The maximal count rate is determined over the area of the gland and the minimal count rate is general body background. For the detection of thyroid carcinoma metastases, the thyroid gland is ignored and the system is set to exhibit its maximal contrast for count rates immediately above the levels in the surrounding tissues.

Scanning of the cardiac blood pool is a clear cut indication for the technique of superimposing a photoscan on to a radiograph. The method is basically that described by Rejali, MacIntyre and Friedell (12). Minimal count rates are set at about 10 per cent above count rates determined over the lung fields adjacent to the cardiac area. Maximal count rates are determined over the heart proper.

In common with other scanning systems the proper selection of isotope dosage, scan speed and time constant, is not rigidly defined at the present and for the most part depends on experience. Variations in these factors can markedly influence the final scan result. Scan speed will in general be determined by the clinical condition of the patient and his ability to cooperate with the scanning procedures. Isotope dosage will, in turn, be governed by scan speed, size of organ or system to be scanned, organ uptake and many intangible factors such as age of patient, diagnosis, prognosis, and consideration of radiation safety factors. While selection of scan speed and isotope dosage will roughly indicate the necessary time constant by means of statistical considerations the final value is dictated by experience.

Once the patient is prepared, the scan parameters selected and the scanning mechanism set in motion, there remains still the intricate task of interpreting the resulting scan. Significant studies are almost completely lacking in this respect and could well afford to be the subject of future work.

The interpretation of any scan involves two distinct problems. One is to determine how well the scan data recording system accurately portrays the input data. This problem is strictly statistical and is discussed in detail in the appendix. The other and much more formidable problem is to establish what scan data patterns constitute normal or abnormal distribution of radioisotopes thus indicating the presence or absence of pathology. Needless to say, many carefully controlled clinical studies will be required to elucidate the many aspects of the problem.

CLINICAL TRIAL

During the spring of 1959, a limited clinical trial of the system was conducted at Highland View Hospital, Cleveland. About 30 patients were included in the trial. Figures 7 thru 14 show representative scans from this series of patients, the majority of which were of the liver. Although limited in scope the effects of variation in some of the more important scanning parameters can be seen by comparing the various scans. No attempt is made to interpret the scans as experience with the system in this respect is very limited at the present time. Figures 7 thru 11 show a series of liver scans using colloidal gold (Au^{198}) and the 19 hole collimator. In Fig. 7 thru 10 the individual scan lines were overlapped 50 percent; and in Figure 11 they were adjacent. Variations in isotope dosage, count rate, scan speed and time constant are as indicated.

The test series contained one brain scan shown in Fig. 12. The scan is of the left side of the head and employed the 19 hole collimator. Adjacent scan lines were overlapped 50 percent.

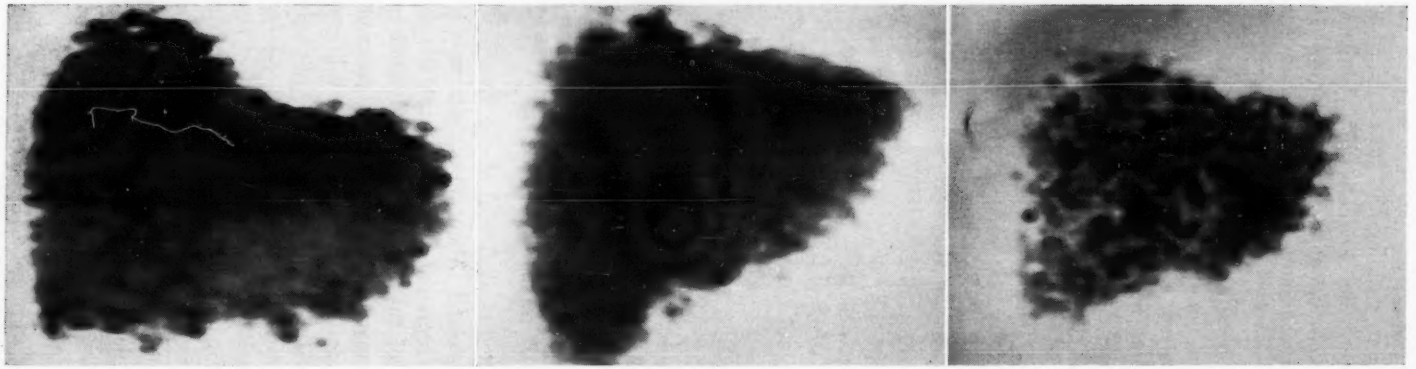

Fig. 7 Fig. 8 Fig. 9

Fig. 7. Hepatoscan of 86 year old male. Clinical Diagnosis: lymphoid leukemia with hepatosplenomegaly. Isotope dose = 500 μc of Au^{198}; max. ave. CPM = 20,000; Min. ave. CPM = 1,000; Scan Speed = 60 cm/min; Time Constant = 1/8 sec. Final Diagnosis (post mortem): leukemic infiltration, liver and spleen.

Fig. 8. Hepatoscan of 67 year old male. Clinical Diagnosis: resolving Wernicke's syndrome. Patient has history of alcoholism and malnutrition with the presence of a palpable liver 2FB below RCM. Isotope dose = 310 μc of Au^{198}; Max. ave. CPM = 16,000: Min. ave. CPM = 1,000; Scan Speed = 60 cm/min; Time Constant = 1/8 sec.

Fig. 9. Hepatoscan of 73 year old male. Clinical Diagnoses: carcinoma of stomach with marked ascites. Isotope dose = 270 μc of Au^{198}; Max. ave. CPM = 1,000; Scan Speed = 60 cm/min; Time Constant = 1/8 sec.

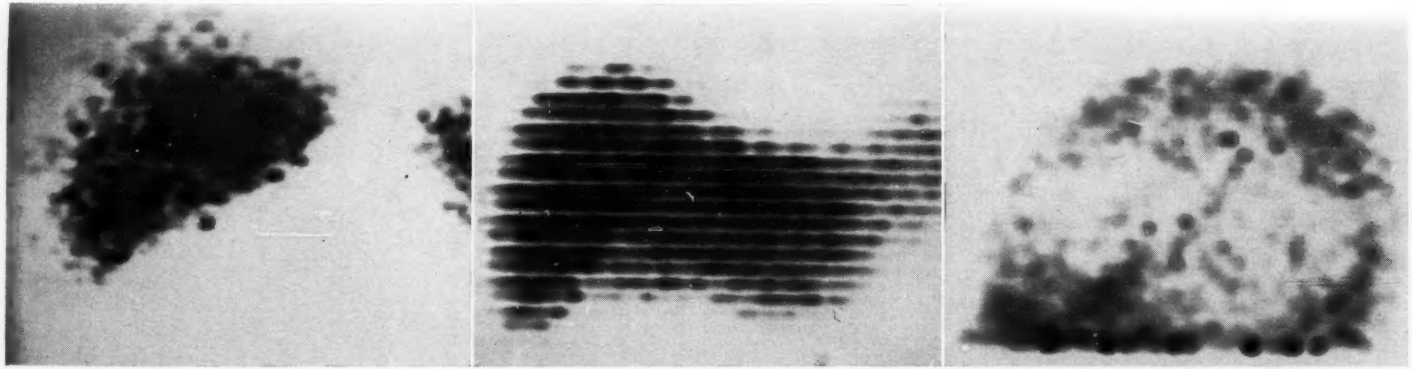

Fig. 10 Fig. 11 Fig. 12

Fig. 10. Hepatoscan of 61 year old male. Clinical Diagnoses: Laennec's cirrhosis. Patient has massive ascites and chronic passive hyperemia of spleen with splenomegaly. Isotope dosage = 75 μc. of Au^{198}; Max. ave. CPM = 2500; Min. ave. CPM = 500; Scan Speed = 30 cm/min; Time Constant = ½ sec. Patient expired 72 days following scan. At autopsy the liver weighed 1160 gm. The external surface was irregular, finely nodular and cut with great difficulty. Sections of the liver revealed a few broad fibrous scars and numerous yellowish-brown nodules 0.2 to 0.5 cm in diameter. The spleen weighed 440 gm and a small section of it can be seen on the right side of the scan (the reticulo-endothelial elements of the spleen will take up some of the Au^{198}). Final diagnoses: Laennec's cirrhosis with ascites.

Fig. 11. Hepatoscan of 44 year old male. Clinical diagnoses: carcinoma of larynx and probable mild Laennec's cirrhosis. Isotope dose = 270 μc Au^{198}; Max. ave. CPM = 16,000; Min. ave. CPM = 1,000; Scan Speed = 40 cm/min; Time Constant = ¼ sec.

Fig. 12. Brain scan of 12 year old female. Clinical diagnoses: inoperable pontine tumor (astrocytoma-grade 2) now 4 months post-radiation following dose of 4630 r to area. Isotope dose 250 μc iodinated human serum albumin; (RISA) Max. ave. CPM = 1500; Min. ave. CPM = 300; Scan Speed = 20 cm/min; Time Constant = ½ sec. Scan was obtained 24 hours following isotope dose administration.

Sample thyroid scans are shown in Fig. 13 and 14. The 19 hole collimator was used in Fig. 13 and the 31 hole collimator in Fig. 14. In both scans adjacent scan lines were overlapped 50 percent.

Overlapping of adjacent scan lines is a perfectly legitimate procedure. Of course, scanning time is increased, but the resulting scan is more easily integrated by the eye (compare Fig. 8 and 11) and statistically more accurate. When the scan lines are overlapped there are more light flashes per unit area on the film, and thus the time length of the light flash must be reduced accordingly to preserve the same average film density over the area.

DISCUSSION

The realm of radioisotope area scanning encompasses scan parameter values over very wide ranges. Target non-target ratios vary from slightly greater than unity to perhaps fifty. Statistical considerations require large variations in scan speed and time constants or integrating factors. As the situation exists, scanning equipment must be highly versatile and yet maintain desirable features of efficiency and fidelity.

The pulsed light photorecording system previously described appears well suited to the demands of the scanning art. The intrinsic versatility and the freedom from inertial effects are outstanding features in this respect. Wide variations in scanning parameters are readily accommodated. The procedure of selecting maximal and minimal count rates associated with a given scanning situation assures that all useful data will be recorded and accurately defines the proper film density range for quantitative considerations. There may be scanning situations where the full range of count rates need not be recorded and thus additional contrast can be realized over the shorter range. In many instances the application of video contrast amplification appears to be a useful adjunct to the full range photorecording.

No one will doubt the apparent complexities of the more successful scanning systems. The search for additional contrast, fidelity, versatility and efficiency often requires elaborate equipment and procedures. Success, however, is in large measure related to a thorough understanding of the advantages and limitations of such devices coupled with an appreciation of the statistical factors on which the scanning art is based.

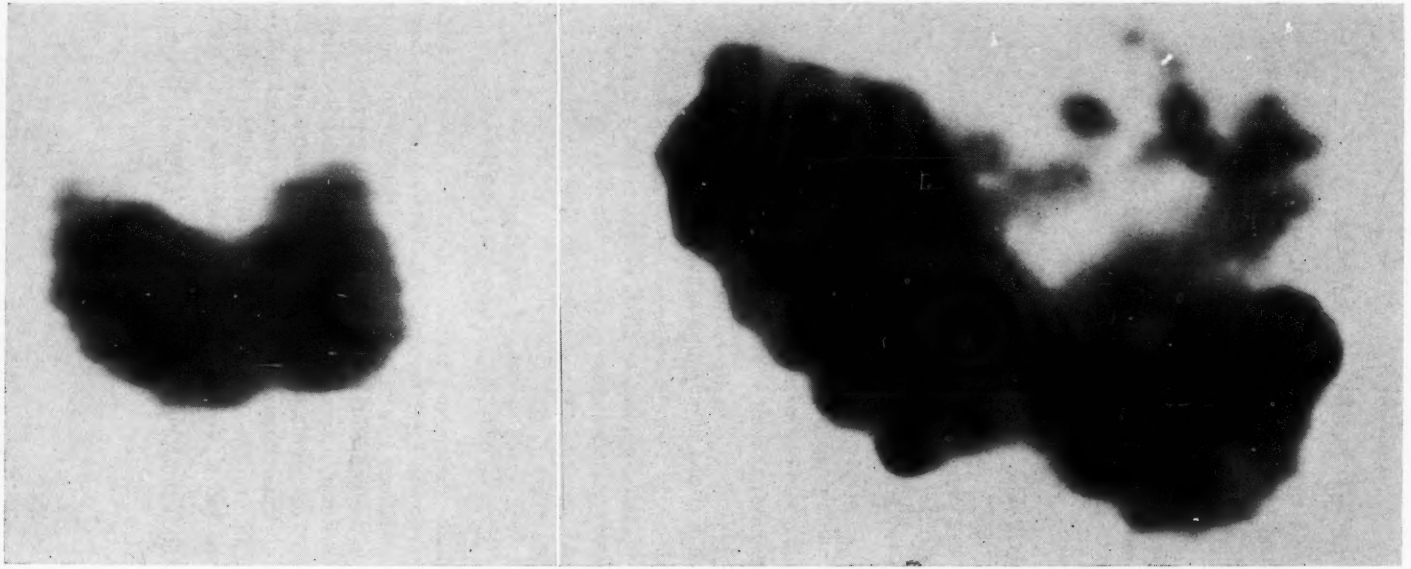

Fig. 13. Thyroid scan of 78 year old male with diffuse palpable gland 3 inch × 2 inch., with discrete small hard nodules bilaterally. Patient also has slight assymmetry of neck with fixed, firm ovoid mass measuring up to 3.5 cm in greatest dimension over left aspect of neck. It is deep and closely attached to underlying structures. The scan covered this area. Isotope dose = 200 μc I^{131}; Uptake = 9.5%; Max. ave. CPM = 20,000; Min. ave. CPM = 1,000; Scan Speed = 60 cm/min; Time Constant = 1/8 sec.

Fig. 14. Thyroid scan of 63 year old female. Clinical diagnoses: massive non-toxic nodular goiter. Isotope dose = 200 μc. I^{131}; Max. ave. CPM = 5,000; Min. ave. CPM = 300; Scan Speed = 40 cm/min; Time Constant = 1/8 sec.

APPENDIX I

THE FILM DENSITY FUNCTION

Steady state system operation may be described mathematically by the following empirically derived formulae relating optical film density to various scan system parameters over the operational range of the system.

$$D = K_1 \frac{(CPM)\,(CPM\text{-}CPM_{min.})\,(W)\,(F)}{S} + 0.3$$

or

$$D = K_2 \frac{(CPM)\,(V\text{-}V_{min.})\,(W)\,(F)}{S} + 0.3$$

Where:

D = optical density of film.

CPM = count rate.

CPM_{max} = maximal count rate to give film density (2.0).

CPM_{min} = minimal count rate to give film density (0.3).

CPM_{fs} = count rate corresponding to full scale deflection of rate meter for selected range.

W = time length of electrical pulse applied to grid of CRT.

S = scan speed.

V = electrical potential applied to CRT second anode (in relation to count rate).

V_{min} = CRT second anode voltage necessary to give film density 0.3. (Approx. 500 volts)

F = contrast amplification factor $= \frac{CPM_{fs}}{CPM_{max} - CPM_{min}}$.

K_1, K_2 = experimentally determined factors which may be considered constants for count rates normally encountered in the average scanning situation, i. e. 10,000 CPM or below. For higher count rates the value of K_1 and K_2 are influenced by the Intermittency Effect, a special case of Photochemical Reciprosity Law failure, the result of an intermittent illumination of the film which is a function of the average illumination and the frequency of interruption. For count rates of 100,000 CPM, the values of K_1 and K_2 are about 1/3 the values for 10,000 CPM.

The above analysis is not valid for minimal count rate (CPM_{min}) less than 2% of (CPM_{fs}).

APPENDIX II

STATISTICAL ANALYSIS OF FILM DENSITY

The film density at any point on the film is related to the number of light flashes superimposed at this point and their relative intensity. The number of light flashes superimposed at any one point is, in turn, related to the count rate, scan speed, the dimensions of the light flash and the scan line spacing. The intensity of the light flash is controlled by the rate meter and associated circuitry. By means of proportional electronic circuitry, statistical fluctuations in light flash intensity are related to the rate meter output voltage which is subjected to statistical fluctuations determined by the count rate and the rate meter time constant.

For scanning operations where CPM_{min} does not equal zero CPM, only a segment of the rate meter output voltage is used in reference to the light flash intensity modulation factor mentioned above. Statistical fluctuations in rate meter output voltage determined by the absolute count rate (CPM) have greater effect when related to a segment of this voltage. The effect increases as the size of the segment decreases and appears to be proportional to the function $\frac{CPM_{max}}{CPM_{max} - CPM_{min}}$. In other words the use of contrast enhancement schemes increases the effect of statistical variations as is readily observed in any scan data recording system employing such devices.

let: σ_f = fractional standard deviation.
A = area of interest on the film.
D_a = average density of film over area (A).
X = number of light flashes occurring in area (A).
Y = an analog of the count rate producing the intensity modulation of the CRT electron beam thru the action of the rate meter and associated circuitry.

It will be assumed that variations of X and Y are independent of each other and thus can be combined as:

$$\sigma_f D_a = \sqrt{(\sigma_f X)^2 + (\sigma_f Y)^2}$$

let: Z = width of light spot along direction of scan line.
H = width of light spot perpendicular to scan line.
A_1 = area of light spot (a function of Z and H). For a circular light spot $Z = H$ and $A_1 = 0.7854\, Z^2$.
X_1 = number of light flashes occurring over an area the size of one spot (A_1) for a single scan line.
S = scan speed
L = spacing between scan lines.
T = time constant of rate meter (expressed in minutes).

$$U = \frac{CPM_{max}}{CPM_{max} - CPM_{min}}$$

then:

$$X_1 = \frac{(CPM)\ (Z)}{(S)}$$

$$X = \frac{(CPM)\ (Z)\ (A)\ (H)}{(S)\ (A_1)\ (L)}$$

$Y = (2T)\ (CPM)$ determined with reference to the analysis of Schiff and Evans (13) which states that a rate meter with time constant (t) has the same statistical accuracy as the result from a message register observed for a time (2t).

$$\sigma_f X = X^{-\frac{1}{2}}$$

$$\sigma_f Y = U\left[(2T)\ (CPM)\right]^{-\frac{1}{2}}$$

thus:

$$\sigma_f D_a = \sqrt{\frac{(S)\ (A_1)\ (L)}{(CPM)\ (Z)\ (H)\ (A)} + \frac{(U^2)}{(2T)\ (CPM)}}$$

The % probable error of D_a is then 67.45 $\sigma_f D_a$.

The formula brings to light some interesting relations, particularly the individual contributions of X and Y in respect to the % probable error of D_a as various scan parameters are changed. The relations, however, will vary over wide ranges depending on the type of scanning. As an example consider the scanning situation in Fig. 1-C and observe the area between cylinders D and G. Scan parameters for this area are: $D_a = 2.0$, $CPM = CPM_{max} = 20{,}000$, $CPM_{min} = 1{,}000$, $T = \frac{1}{8}$ sec, S = 23.6 in./min, $L = \frac{1}{8}$ in. and $Z = H = \frac{1}{4}$ in. The % probable error as calculated for a circular area the size of one light spot is 8.4% If the scan speed had been ½ the above value and all the other parameters remained the same the probable error would be 8.1%. Now, if instead only the rate meter time constant had been changed to twice its original value, the probable error would be 6.4% Again holding all other factors constant and doubling the count rate, the probable error is 5.95%. Likewise, if the circular area of observation had been increased to twice its diameter (4X the original area), the probable error would be 7.95%. From the example it would appear that the rate meter time constant is the primary contributor to the probable error; however, with other values of scan parameters its effect could be nil and other factors would become prominent.

One final word concerns the response of the system to count rate change. This, of course, is determined by the system time constant; however, this is not the rate meter time constant. Transient response of the film density function produced by a changing count rate, has two components. One is determined by the changing number of light flashes, and to this the system can respond instaneously for all practical purposes. The other component is the changing intensity of the light flashes and is controlled by the rate meter time constant. Depending on the magnitude of the count rate changes, which will determine the relative values of the two components, the system can partially respond instantaneously and thus a measure of absolute fidelity is preserved.

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JOURNAL OF NUCLEAR MEDICINE, 2, 102-131 (1960)

Abstracts of Papers to be Presented at the Seventh Annual Meeting of the Society of Nuclear Medicine, Estes Park, Colorado, June 22-25, 1960

1. ***A Binding Coefficient Proposed as an Index of Thyroid Function in the Labeling of Red Cells in Vitro with I^{131} Tagged 1-Tri-Iodothyronine.*** **RALPH ADAMS, (Nuclear Medicine Division, Department of Radiology, The College of Medical Evangelists School of Medicine, Los Angeles 33).**

Hamolsky and other investigators have shown the degree of labeling of red cells *in vitro* with 1-tri-iodothyronine to be a function of the thyroid status of the plasma donor. In this method the measured fraction of the activity taken up by the cells is corrected to a hematocrit of 100 percent.

The author reports in this paper a study of the labeling of red cells in blood samples prepared with widely varying hematocrits. It is shown that the red cell uptake as corrected to a 100 percent hematocrit by Hamolsky's method increases considerably with hematocrit. This variation is sufficient to explain the difference in the average euthyroid red cell uptake between males and females reported by others.

It is shown that the labeling obeys an equation derived from the law of mass action. The activity taken up by the cells is proportional to the product of the red cell mass and the activity concentration remaining in the plasma at the end of incubation. The constant of proportionality, or binding coefficient, is nearly independent of the hematocrit and should be a more reliable index of thyroid function than the percent red cell uptake per 100 percent hematocrit.

Reversability of labeling, elution during washing of cells, and other problems with the procedure are discussed.

2. ***On the Nature of Radioactive Iodinated Amino-Acids in Thyroid Nodules and Normal Thyroid Tissue.*** **HERBERT C. ALLEN, JR. AND JAMES A. CHAMBERLIN, (Department of Nuclear Medicine, The Hermann Hospital and Methodist Hospital, Texas Medical Center, Houston).**

A total of 96 patients with various types of thyroid diseases have been screened over the past 1½ years. A detailed study of 20 of these patients has been made in which the radio-iodinated protein composition of nodular and perinodular thyroid tissue, as well as cystic fluid and thyroidal venous plasma, has been compared. The radio-iodinated amino acid composition of these tissues has likewise been examined. The types of normal and abnormal thyroid tissue studied were: Follicular adenoma—12, Adenomatous goiter—2, Chronic thyroiditis—3, and Diffuse hyperplasia—3.

Patients included in the detailed study received between 150 and 920 microcuries of carrier-free radioiodine, I^{131}, 18 to 120 hours prior to surgical removal of the thyroid gland. At the time of surgery, 20 ml of thyroidal venous blood was removed from the most promi-

nent thyroid vein overlying the thyroid adenoma prior to any major manipulation of the thyroid gland by the surgeon. Following surgical removal of the thyroid gland, cystic fluid, if any, was removed from the adenoma. The solitary nodules were carefully dissected intact from the perinodular tissue of the thyroid gland and the parenchyma of the nodule carefully scraped from the interior of the capsule. Histologic sections were made on all nodular and perinodular tissue dissected for study. Radioassays were routinely made of the nodular, perinodular tissue, cystic fluid and plasma. Tissue removed for study was homogenized under liquid nitrogen and paper strip electrophoresis was done on the supernatant tissue fluids.

Seventy two hour enzymatic (Armour Trypsin) hydrolysis of the remaining homogenates were done and extracted with butanol saturated with 0.1 N HCL. Both one dimentional and two dimentional ascending chromonatgraphic techniques were used employing as solvant systems butanol acetic acid and tertiary amyl saturated with 2N ammomium hydroxide. The location of the radioactive iodinated amino-acids were identified by automatic Geiger-Mueller scanning and autoradiographs of the strips.

Radioactive MIT and DIT were readily found in all normal thyroid tissue removed up to 96 hours after the administration of I^{131}. After 96 hours, radioactive thyronines were readily observed in normal tissue.

In one of eight cases (NS #106) of a solitary hypofunctioning (5 percent) follicular adenoma which co-existed with struma lymphomatosa, a radioactive iodinated compound Rf = 0.75 (T_3 = 0.76) was found in the thyroidal venous plasma, whereas, in a similar case of Hashimoto's disease without nodular formation, (OS #105) a radio-iodinated compound with Rf = 0.84 (T_4 = 0.83) was the predominent radio-iodinated compound in the thyroidal venous plasma.

In tissue removed from two-thirds of the cases showing Hashimoto's thyroiditis, three distinct radio-iodinated compounds with Rf = 0.83 (T_4 = 0.83); Rf = 0.68 (T_2 = 0.73); Rf = 0.62 (DIT = 0.59), have been consistently found.

Other known and unknown radio-iodinated compounds found in adenomatous goiter and thyrotoxicosis will be presented. In addition, a comparison of the radio-iodinated amino acid in follicular adenomas and the adjacent perinodular tissue will be discussed.

3. *Neutron Spectroscopy As Applied to the Brookhaven Medical Research Reactor.* CHARLES G. AMATO, (Medical Physics Division, Medical Department, Brookhaven National Laboratory, Upton, New York).

Neutron irridiation is beginning to receive increasing attention by biologists and doctors for research and therapy purposes. The successful use of any form of radiation requires an accurate quantitative and qualitative measurement of the radiation. Various techniques of neutron spectroscopy are possible. A reasonably simple and straight-forward method based on radioactivant analysis will be described. Emphasis will be on technique and pitfalls. This method is capable of easy application by any research organization and hospital. Two other methods will be briefly discussed.

4. *Solid-state Dosimetry.* CHARLES G. AMATO, (Brookhaven National Laboratory, Medical Physics Division, Medical Department, Upton, L. I., N. Y.).

A properly shielded radiophotoluminescent glass needle, 6 mm long, exhibits a wide range of uniform response in air and in depth to the commonly accepted therapy radiation sources. It has been successfully implanted in the chest wall, cervix, bladder, liver, and esophagus. Implant techniques are being developed to permit its entry into the rectum, lung, bone, and heart.

The limitations upon this needle which apply if it were to be used as a spectrometer will be presented.

Techniques for using this glass dosimeter to measure gamma dose delivered, in the therapy beam of the Brookhaven Medical Reactor, and accompanied by an intense neutron flux, will be described.

5. *The Treatment of Inoperable Lung Cancer by Combined Radioisotopes.* **IRVING M. ARIEL, (New York).**

Patients with carcinoma of the lung found to be inoperable at the time of thoracotomy have an average survival of six months. Frequently, during much of this period the patient receives palliative external x-ray therapy.

The author has utilized the exposure of the lung cancer to infiltrate the cancer with combined radioactive isotopes in thirty patients. The palliation has often been great and increased survival has been obtained by this regimen. The isotopes used have been radioactive gold, radioactive chromic phosphate, radioactive yttrium, radioactive iridium, and silver-plated radioactive gold, administered interstitially either as a single isotope or in combination.

The availability of radioactive isotopes for interstitial administration broadens the indications for exploratory thoracotomy; and a regimen will be described whereby a patient suspected of having lung cancer by roentgenography can have a definitive diagnosis established, definitive evaluation of the extent of the cancer, and interstitial irradiation of the cancer in a period of about one week.

6. *Effects of localized doses of high intensity X-irradiation on the Cardiovascular System of the Rat.* **R. BARATZ, W. S. MOOS, R. A. HARVEY, (Department of Radiology, University of Illinois, College of Medicine, Chicago).**

Rats were irradiated with very high x-ray dosages (10^5 to 10^6 r) to the abdomen or head. Tests were carried out to follow heart rate, arterial pressure, rectal temperature, changes in blood volume (Using RISA). Disappearance of RISA from the vascular tree did not indicate a significant capillary permeability whereas autopsy findings and total body scanning indicated marked vascular damages.

7. *Total Exchangeable Potassium Determination in Saliva.* **FRANZ K. BAUER, NANCY TELFER, JUANITA LESTINA, AND MARVA JENKINS, (University of Southern California and Los Angeles County Hospital, Los Angeles).**

Saliva, which is rich in potassium, was used to determine its applicability as a substitute for urine in total exchangeable potassium (TEP) studies. TEP is determined by the dilution principle using short-lived K^{42} with equilibrium occurring throughout the body within 24 hours.

Since urine specific activity (SA) has been shown to be representative of the mean body SA at equilibrium, a "spot" urine sample is taken 24 hours after the administration of a tracer dose of K^{42} and its SA is determined. Urinary loss of the tracer dose is usually less than 10 percent in 24 hours; in anuria this loss need not be taken into account.

Urinary and salivary TEP was determined concomitantly in 10 patients with various disorders. Saliva was obtained by having the patients chew on a piece of canning paraffin for approximately 5 minutes. A 5 ml sample was then assayed for radioactive (K^{42}) and stable (K^{39}) potassium. The results showed close correlation between the urinary and salivary specific activities.

Since rubidium has been shown to behave qualitatively similar to potassium in a number of biologic systems, Rb^{86}, a gamma emitting isotope of rubidium was used as a substitute for K^{42}. Exchange of Rb^{86} with K^{39} in saliva was comparable to K^{42} 24 hours after administration of the tracer dose. The specific activities K^{42}/K^{39} and Rb^{86}/K^{39} were identical.

Because of its longer physical half-life (19.5 days) Rb^{86} may be used to advantage instead of K^{42} for the measurement of salivary total exchangeable potassium.

8. *A Theoretical Evaluation of Brain Scanning Systems.* **ROBERT N. BECK, (Argonne Cancer Research Hospital, Chicago).**

Two fundamental questions concerning brain tumor scanning are answered in this paper:
(1) What are the relative merits of focusing collimator systems and coincidence systems?
(2) How does the effectiveness of a focusing collimator system vary with gamma energy?

To answer these questions, it has been necessary to develop a theory of focusing collimators for distributed sources which is applicable to all medical isotope scanning. This theory makes it possible to design optimum focusing collimators, i.e., having highest possible efficiency, for a given gamma energy, collimator material, crystal diameter, focal length, radius of resolution, and permitted penetration fraction. Optimum collimators for 300 combinations of values of these variables have been designed on Univac for the energy range of 200 Kev to 500 Kev.

It is shown that for most combinations of typical values of resolution, tumor size and depth, uptake ratio, and concentration of isotope, an optimum focusing collimator system for Hg^{203} (279 Kev) is superior to both an optimum system for I^{131} and a coincidence system. Preliminary experimental evidence is in excellent agreement with the theory.

9. *Radioactive Contour Myelography in Infants.* **ROBERT L. BELL, (Department of Surgery, State University of New York, Downstate Medical Center, and the Neurosurgical Service, Kings County Hospital, Brooklyn).**

A semiautomatic device which maintains constant geometric relation to variable skin curvatures will be described, as well as its application in the performance of radioactive myelography. In particular, several cases will be presented to show the simplicity and accuracy of the method in demonstrating subarachnoidal block in young infants so that the use of radiopaque oil myelography is not necessary. The contour scanning pictures will be correlated with the standard roentgen projection.

10. *Autofluoroscopy: The Use of a Non-Scanning Device for Tumor Localization with Radioisotopes.* **MERRILL A. BENDER, AND MONTE BLAU, (Roswell Park Memorial Institute, Buffalo).**

A major drawback of scanning is the length of time required to perform the scan. Many patients are unable to remain still for the required period of time and for many procedures the scan time is so long that only a few patients can be examined in a day. In addition, dynamic processes cannot be visualized and relatively slow changes in isotope content can result in incorrect interpretations.

A fixed device has been designed which can record the same information in less than one-tenth the time needed to obtain a scan. It is believed the instrument will be capable of visualizing slow dynamic processes.

This "autofluoroscope" will consist of a lead collimator containing 275 tapered channels, hex packed, with 1 cm on center separation. Each channel will be backed by a ⅜" diameter, 2" thick NaI (Tl) crystal. A photoelectric event occurring in a given crystal will be displayed in proper position on an oscilloscope by a modification of the method of data transfer devised by Anger. The oscilloscope will be viewed by a closed circuit television unit to give the high contrast needed to resolve small differences in count rate.

The large total crystal area with a moderate loss in resolution are the main factors in reducing the time needed to record the information. An additional reduction results from the superior target:non-target ratios obtained from a single very small aperture in contrast with a focusing collimator. Since the detector is fixed, massive side shielding can be used to limit unwanted scatter and background.

Design considerations will be explored in detail and the results of studies with a 20 crystal prototype will be presented.

11. *Use of Intravenous Radioactive Fat Emulsion in the Study of Lipid Metabolism.* **DONALD BERKOWITZ, AND DAVID M. SKLAROFF, (Albert Einstein Medical Center, Philadelphia).**

Recently there became available for clinical use an emulsion of triolein tagged with I^{131} which is suitable for intravenous administration. Since previous studies with oral radioactive fat have demonstrated characteristic patterns in the blood in normal patients and in patients with various diseases, this new material was used in the study of similar groups of patients.

2-3 ml of the emulsion containing 10-15 μc of I^{131} labeled triolein were injected slowly by intravenous. Blood samples were obtained at frequent intervals in the following 24 hours and the radioactivity of the blood was determined.

A rapid decrease of the radioactivity in the blood of normal patients was noted in the first 30 minutes at which time over 85 percent of the administered fat had already left the blood. Abnormal curves were obtained in patients with lipid metabolic disorders. These results will be compared with the results obtained with similar patients using the oral test meal. Abnormal oral radioactive fat tolerance tests were usually associated with an abnormal intravenous test.

This test was found to be safe and well tolerated by the patient. No reactions were noted.

12. *A Radioisotope Concentration Gradient Analyzer for Determination of Electrophoretic Mobilities and Sedimentation Velocities of Labeled Proteins.* **SOLOMON A. BERSON, AND ROSALYN S. YALOW, (Radioisotope Service, Veterans Administration Hospital, Bronx, N. Y.).**

Measurements of sedimentation velocity and free electrophoretic mobility of proteins in the presence of significantly higher concentrations of other proteins and the detection of protein-protein and small molecule-protein or ion-protein interactions are generally not feasible by usual optical methods.

The present system was designed to overcome these limitations by employing radioisotopically labeled compounds and a radioactivity scanning and recording apparatus. Following a preparative run, the electrophoresis cell or ultracentrifuge tube is automatically scanned by a wafer-shaped sodium iodide crystal in a heavy shield with a narrow slit aperture. The output from a count rate meter, proportional to concentration along the path of migration or sedimentation, is recorded as such and in addition is led into a rate of change computer to be recorded simultaneously as concentration gradient. The peaks of the gradient curves serve to localize the positions of the migrating or sedimenting boundaries of the labeled compounds unobscured by the presence of other substances. Millimicrogram amounts of I^{131}-labeled proteins in plasma may be analyzed in this way. Internal standardization may be provided by inclusion of a labeled protein of known electrophoretic mobility or sedimentation velocity. Under appropriate conditions 5 or more boundaries per inch path length can be distinctly resolved. Determination of the presence and extent of binding of labeled ions, small molecules, hormones and other proteins at low concentration and investigation of the charge and molecular weight characteristics of soluble antigen-antibody complexes and of hormone-binding plasma proteins are projects under current study or susceptible to analysis by these methods.

13. *Clinical Evaluation of Hg^{203} Neohydrin and I^{131} Albumin in Brain Tumor Localization.* **MONTE BLAU, AND MERRILL A. BENDER, (Roswell Park Memorial Institute, Buffalo).**

Hg^{203} labeled Neohydrin and I^{131} labeled human serum albumin (RISA) have been compared as agents for brain tumor localization by gamma ray scanning in more than 50 patients. In each case a set of scans was obtained 3-6 hours after the administration of 300-750 microcuries of Hg^{203} Neohydrin. After scanning 250-400 microcuries of I^{131} albumin were injected and

the scans repeated in 24-48 hours. Pulse height analysis eliminated any interference of Hg^{203} gamma rays (.28 Mev) with the I^{131} (.36 Mev) scanning.

Visualization of primary brain tumors was significantly better with Neohydrin. The difference was less marked with metastatic lesions but in almost every case the Neohydrin was as good as or somewhat better than albumin.

These clinical results confirm the theoretical advantages of Hg^{203} Neohydrin over I^{131} albumin. The rapid clearance of non-localized Neohydrin from the blood and the effectiveness of collimation and shielding on the monoenergetic .28 Mev gamma rays from Hg^{203} probably account for the improved visualization of tumors with this agent.

14. *Analysis of the Diodrast Renogram.* **ALVIN S. BLUM, (Radioisotope Service, Veterans Administration Hospital, Coral Gables, Florida).**

Our experience with 250 renograms indicates that the maximum diagnostic information inherent in the three phases of the renogram can only be obtained by careful control of the material, instrumentation, and interpretation. From evidence of simultaneous radiocardiogram and renograms, it appears that the initial "vascular" peak is not radioactivity in the renal circulation, but is radioactivity in the lung, appearing in the field of an incompletely shielded kidney detector. This simultaneous radiocardiogram-renogram method can also be used to demonstrate the characteristic pattern of the renogram that results from impaired systemic circulation.

Proper choice of ratemeter time constant is vital to the second phase of the renogram. Too short a time constant causes the rise in activity due to kidney concentration of diodrast to be obscured by the erratic peaks of the same height resulting from random fluctuations in the counting rate. However, too long a time constant causes a delayed exponential rise in the curve of a non-functioning kidney indistinguishable from the pattern of some functioning kidneys, especially when the contralateral kidney is functioning. A solution to this quandary is to use a short time constant with a larger dose and a more sensitive detector.

The final phase of the curve, (urinary drainage) should approach zero if all radioactivity represents a material excreted as rapidly as diodrast. Since it approaches a plateau, some of this radioactivity may be in a different chemical form. Some evidence that other forms are present will be discussed.

15. *Evaluation and Management of the Heavily Irradiated Individual.* **VICTOR P. BOND, (Div. of Microbiology, Medical Research Center, Brookhaven National Laboratory, Upton, N. Y.).**

After an accident involving radiation exposure it is of considerable importance to determine as soon as possible the dose in rad to which potential accident victims have been exposed. However uncertainties in dose determinations, and in dose effect relationships in man make dose calculations or determinations only an important adjunct to biologic and medical findings in evaluating therapy and prognosis. Considerable information on the "effective dose" that an individual has received and his probable prognosis can be derived from clinical signs and symptoms within hours and days following exposure. At doses up to approximately the "LD_0" range, individuals do well and recover apparently completely in the absence of any therapy directed specifically at the effects of the exposure. At higher doses, experiments in dogs borne out by clinical experience have shown that large doses of antibiotics, and large transfusions of fresh platelets will allow survival in individuals at exposure levels approximately twice that from which they otherwise would have died. At doses above these levels, serious consideration must be given to bone marrow replacement therapy.

16. ***Determination of Radioactivity in a Stool Specimen: A Direct Method Employing a Standard Carton with a Modified Well Counter.*** **JOHN D. BONNET, NICHOLAS C. HIGHTOWER, AND ARNO W. SOMMER, (Scott and White Clinic, Temple, Texas).**

In the average isotope laboratory without expensive equipment, radioactivity in a stool specimen in a standard carton can be determined accurately and simply by using a modified well (probe) sodium iodine crystal. An adaptor is placed to maintain a constant geometric relationship between the crystal and the standard carton. The number of counts from a quantity of radioactivity contained in different volumes is a function of height. By applying a correction factor, determined from a curve constructed by counting radioactivity of the stool at different heights in the carton, Fe^{59}, I^{131}, or Cr^{51} in stool specimens can be determined directly with a modified well counter. It is not necessary to handle the stool specimen more than tamping it to a minimum height.

17. ***The Influence of Estradiol on "Apparent" Phosphotidylcholine Synthesis in Sprague Dawley Rats.*** **E. N. BOWSER, W. HENDERSON, AND H. J. ZIMMERMAN, (Radiostope Service, Veterans Administration West Side Hospital, Chicago).**

Estradiol inhibits nutritional fatty metamorphosis in the liver of the intact and castrate rat. The mechanism of the effect of this hormone remains obscure. In a previous investigation, it has been shown that "lipotropism" observed with estradiol administration differed from that of methionine, since the latter produced a favorable effect in both liver fat and body weight. Nevertheless, it was considered that the administration of estradiol might possibly spare or stimulate the synthesis of choline. Since vitamin B_{12} is important in the biosynthesis of methyl groups and is "choline sparing", the effects of estradiol and this vitamin were compared in 90 castrated female Sprague Dawley rats. Choline synthesis was measured indirectly by observed changes in the following: 1) Severity of fatty metamorphosis, 2) lecithin concentration, 3) rate of P^{32} incorporation into lecithin in rats on a normal diet, a high fat low protein low choline diet, and a high fat low protein low choline diet supplemented with vitamin B_{12} (30 μg/Kg diet).

Chronic estradiol administration prevented the formation of fatty livers similar to that reported for choline, and which has also been described for vitamin B_{12} under certain dietary conditions. All three of these substances increased the lecithin concentration of the liver; yet only choline restored the apparent high rate of phospholipid synthesis characteristic of choline deficient animals to normal. Accordingly, we have inferred that both estradiol and vitamin B_{12} differ in their mode of action from choline. Furthermore, the mechanism of estradiol differs from that of vitamin B_{12} since these two have approximately the same effect on lecithin and relative specific activity of lecithin, but do not inhibit fatty metamorphosis to the same extent.

18. ***Isoresponse Studies.*** **MARSHALL BRUCER, (Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge).**

The first item that any physician must know before he uses a radioactivity detector is ...tly what the detector is looking at. Many different kinds of collimators are used in the ...ction and measurement of radioactivity in the human body. With most of the detectors ...in clinical medicine a minor deviation in position can lead to a major deviation in radia... ...ounting. Sometimes, but not always, they make a major difference in the diagnostic or ...eutic assessment of clinical significance. The determination of the field of vision of any ...r is a simple procedure.

19. *The Statisticator.* MARSHALL BRUCER, (Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge).

The average of two readings is not better than either of the individual readings. This is only true in infinite numbers of small samples. Medicine deals with small numbers of small samples. The statistics that must be learned by a physician using radioactivity are an example of an experimental approach to the easiest kind of statistics. The differences between proof, demonstration, and suspicion are shown on a Pascal triangle. This ancient device is used to teach physicians that suspicion is sufficient for clinical purposes. Demonstration is exceedingly expensive and is for scientists. Proof is a mathematical fiction in medicine.

20. *Summary of Nine Years of the Use of Radioactive Colloids in Intracavitary Injection.* R. Y. CARD, D. COLE, AND U. HENSCHKE, (Dept. of Radiology, St. Mark's Hospital, Salt Lake City).

Since its introduction in 1950, the intracavitary injection of radioisotopes has had wide application. The established indications are the destruction of free cancer cells inevitably produced by surgery and the suppression of malignant effusions. Five-year results of the first use are very meager but the results of over 1700 patients published to date show gratifying effectiveness in fluid suppression. The basis of patient selection has been established. The mechanism of action remains unknown but is interestingly conjectured. Many studies of the pathology and side-effects have been published.

In addition to colloidal radiogold, Au^{198}, chromic radioactive phosphate, P^{32}, and radioyttrium, Y^{90}, have been injected intracavitarily. The physical and biologic properties of each have been set forth and the advantages of chromic phosphate are emerging to make it the agent of choice.

The results of treatment of a total of 1658 patients, including over 200 of our own, have been reviewed up to September, 1958 and revised up-to-date figures will be presented. Suppression of fluid formation was accomplished in 54 percent of intrapleural, 50 percent of intraperitoneal, and 66 percent of intrapericardial injection. The results of P^{32} and Y^{90} are slightly better than those of Au^{198} but only the gold patients constitute a statistically significant number.

A comparison with intracavitary injection of chemotherapeutic agents is made.

21. *The Clinical Importance of Erythrocyte and Plasma Volume Determinations Before and After Open-Heart Surgery.* EDWARD A. CARR, JR., HERBERT E. SLOAN AND ENRIQUE TOVAR, (Depts. of Internal Medicine, Surgery, Pharmacology and the Clinical Radioisotope Unit, University of Michigan Medical Center, Ann Arbor).

We studied blood volumes (BVs) in 12 patients before and (except in one dying at operation) after open-heart surgery with extra-corporeal circulation (roller pump and disk oxygenator). Extraordinary opportunities for BV disturbances would seem to exist here. Both Cr^{51} labeled erythrocytes and I^{131} labeled albumin were used in each patient, thus avoiding assumptions about the ratio of whole body hematocrit to peripheral hematocrit, a ratio which is variable in illness. As actually measured in our patients this ratio had a coefficient of variation of 9 percent about a mean of 0.90.

Despite replacement based on careful collection and measurement of all blood lost, three patients' erythrocyte volume (EV) *and* whole blood volume (WBV) *both* changed by > 700 and > 400 ml, respectively. One of these (thoracic aortic aneurysm) survived after an unsatisfactory post-operative course. The other two, one of whom had the tetralogy of Fallot and the other, mitral valve disease, died. Autopsy showed no specific cause of death. A fourth, plethoric pre-operatively, was deliberately made more normovolemic after repair of his interatrial septal defect and did well. The other seven (3 with interatrial septal defects, 2 with tetralogy of Fallot, 1 with mitral and 1 with pulmonary valve disease) survived, though *either* the above EV *or* WBV changes (not both) occurred in three. In

patients with diseased hearts inaccurate replacement based on measured blood loss allows changes which, especially if reflected in both EV and WBV, may lessen survival. Serial EV and WBV determinations are thus useful in decreasing mortality.

22. *Low Dose Effects of Total Body Irradiation As Observed in Clinical Use of Total Body Irradiation.* **VINCENT P. COLLINS, (Baylor University College of Medicine, Houston).**

For many years total body irradiation has been used in the treatment of leukemia, lymphosarcoma, and polycythemia. This technique of radiotherapy has been extended to instances of disseminated cancers of radiosensitive types. Time-dose relationships and the range of symptomatic and hematologic response are reasonably well documented in the range below the minimum lethal dose. It is in this same range that the greatest number of exposures are apt to occur under occupational, accidental or catastrophic conditions. It is generally expected that circumstances will arise when exposure to radiation must be deliberately accepted. In weighing necessity versus risk, available experience with total body irradiation is applicable to evaluating the immediate and late effects of such exposures.

23. *Exchangeable Sodium and Potassium in Primary Aldosteronism.* **M. G. CRANE, J. J. HARRIS, AND J. E. HOLLOWAY, (College of Medical Evangelists School of Medicine, Los Angeles).**

Primary aldosteronism is a syndrome characterized by hypertension, polydypsia, polyuria, hypokalemia, and metabolic alkalosis, caused by an adrenal cortical adenoma (or less frequently adrenal cortical hyperplasia) which secretes excess quantities of aldosterone. Aldosterone causes sodium retention and potassium excretion without water retention. Diagnosis of the syndrome has been hampered because of the variability of the clinical and laboratory findings. We have found twenty-four hour exchangeable sodium (Na_e) and potassium (K_e) measurements helpful in diagnosing five cases.

K_e was measured using the specific activity of K^{42} on a one hour urine specimen at the end of twenty-four hours of equilibration. Na_e was measured the day following K^{42}, using the specific activity of Na^{22} on a twenty-four hour serum sample.

Six measurements were made on five patients with primary aldosteronism preoperatively. The Na_e ranged from 46.4 to 57.3 and averaged 50.3 ± 4.1 mEq/Kg, the K_e ranged from 28.9 to 39.4 and averaged 34.0 ± 3.9 mEq/Kg, and the ratio of Na_e to K_e ranged from 1.34 to 1.61 and averaged 1.48 ± 0.01.

Four determinations were made on three of these patients after removal of the aldosteroma. The Na_e ranged from 39.8 to 42.9 and averaged 41.3 ± 1.4 mEq/Kg, the K_e ranged from 34.9 to 47.5 and averaged 40.0 ± 5.4 mEq/Kg, the Na_e/K_e ratio ranged from 0.88 to 1.15 and averaged 1.04 ± 0.12.

In six controls the Na_e/K_e ratio ranged from 0.82 to 1.26 and averaged 1.01 ± 0.15. Eight patients with hypertension due to causes other than primary aldosteronism had Na_e/K_e ratios ranging from 1.14 to 1.37 and averaged 1.26 ± 0.10.

24. *A Comparison of I^{131} Rose Bengal and Colloidal Gold^{198} in Liver Scanning.* **GODOFREDO GOMEZ CRESPO, WILLIAM J. MACINTYRE, AND JAMES H. CHRISTIE, (Radioisotope Laboratory, Highland View Hospital, Cleveland).**

The general use of I^{131} Rose Bengal for visualizing the structure of the liver has been accompanied by many problems inherent in utilizing a material which is both accumulated and released at rates varying considerably from patient to patient. These difficulties have been three fold: First, a continually changing counting rate cannot be readily adapted to a set accentuation technique, since a setting at the early part of the scan may not be optimum at the

end. Secondly, the concentration in the gall bladder is recorded as an area of activity much greater than the surrounding liver tissue. Third, and perhaps the most important problem, involves the release of the material into the intestines before the scan is completed, thus obscuring the limits of the liver and presenting artifacts indistinguishable from normal liver tissue.

While Colloidal Gold, Au^{198}, has eliminated both the time dependence and release problems, its use has raised the questions as to whether the distribution of this substance in the reticulo-endothelial cells will provide the same clinical information as the deposition of I^{131} Rose Bengal in the polygonal cells.

For this purpose, fifty patients have been scanned at similar counting rates with both I^{131} Rose Bengal and Colloidal Gold, Au^{198}. This group has included both normals and such pathological conditions as metastatic disease and cirrhosis. The comparison will be persented along with a discussion of the ability of colloidal gold to visualize such empty vascular spaces as the hilus, areas of infarction and engorged vessels in passive congestion.

25. *The Use of a Photocopying Process for Erasing the Background of Photoscans Representing a Radioactive Target Region Located Inside a Large Nontarget Region.* **WILLIAM C. DEWEY, AND JOAN G. CUNNINGHAM, (Physics Department, The University of Texas M. D. Anderson Hospital and Tumor Institute, Houston).**

Scintiscanning equipment was used to obtain a photoscan presentation of a target region having a different concentration of radioactivity than the surrounding nontarget region. An appropriate collimator-detector system was chosen, based on a criterion involving a compromise between resolution and sensitivity. The photoscanning equipment consisted of a modulated neon light which increased in intensity as the counting rate increased. The presentation of the target area on the photoscan was improved by reproducing the photoscan by means of a photocopying process which erased the nontarget background. The particular optical densities or counting rates to be erased were accurately specified, and a series of reproductions were obtained with different amounts of background erased. The same presentation of the data could be obtained with either the electronic background erase system or with the photocopying process.

26. *Three Years of Experience in the Therapeutic Use of Radioactive Gold Grains.* **ROBERT J. DICKSON, (Department of Radiology, The Johns Hopkins Hospital, Baltimore).**

In February 1957, a gun designed at the Royal Marsden Hospital, London, for the implantation of radioactive gold grains was acquired. Initially, the use of this gun was sporadic but for the past two years a regular supply of radioactive grains has been delivered every week and they are always available for clinical use on immediate demand.

Some fifty patients with a variety of accessible lesions have been treated with radioactive gold in solid form and these lesions are analyzed. The versatility of the implement and the satisfactory clinical responses obtained are demonstrated in the multiplicity of lesions which have been treated with satisfactory palliation.

The economy of this material relative to radon is emphasized.

27. *A Device for Safely Milking Carrier-free Yttrium-90 from Strontium-90.* **R. F. DOERING, W. D. TUCKER, AND L. G. STANG, JR., (Hot Laboratory, Brookhaven National Laboratory, Upton, New York).**

Yttrium-90 is a radioisotope of interest in medical and biological research, and one which has potential therapeutic application. It is a short half-life (64 hours) pure beta emitter (2.27 Mev s). While it has been available commercially, it has been relatively expensive. Because of its short half-life, it is not feasible to keep a supply on hand.

Since it is the daughter of a long-lived parent, Sr^{90} (28-year half-life), the basis exists for a milking system by means of which Yt^{90} could be obtained as desired by separating it from its parent. However, the extreme toxicity of Sr^{90} prohibits the handling and storage of millicurie amounts of it in the average isotope laboratory. Several methods of milking Yt^{90} from Sr^{90} have been devised over the past few years, but none of them combines simplicity and safety of operation with a product essentially free of Sr^{90} contamination.

The present method permits the milking of up to 100 mc of yt^{90}, carrier-free, in absolute safety, in about 30 minutes. The ratio of Sr^{90} to Yt^{90} in the product solution is less than 10^8. The Sr^{90} is fixed on a Dowex 50 × 8 cation exchange resin within a glass column. This column is shock-mounted within a cylindrical Lucite container that serves to protect it and acts as a shield against the beta radiation. The product delivery tube may be retracted within the container for protection during shipping and storage. Operation of the "generator" consists of pouring 100 ml of a 0.5 per cent citric acid solution, whose pH has been adjusted to 5.50, into the top of the generator. Immediately, the product solution starts to drip from the delivery tube. When 100 ml have run through the column, an alumina "valve" stops the flow cleanly, so that it is not necessary for anyone to watch the generator during its operation.

As a safeguard, a method has been devised for assaying the product solution for Sr^{90} contamination. This method will detect as little as 0.01 μc of Sr^{90} in the presence of 100 mc of Yt^{90} takes about 1 hour to perform, and requires no specialized technique.

28. *A Body Cross-Section-Scan Phantom for the Study of Scintillation Collimators.* **Arthur F. Dratz, James C. Coberly, and Robert H. Rohrer, (Radioisotope Service, Veterans Administration Hospital, Atlanta and the Department of Medicine and the Department of Physics, Emory University, Atlanta).**

The effects of collimator design on radioactive renogram determinations are being studied by the use of a phantom. At constant speed and spacing, a commercial scanning mechanism moves a small mock iodine source through a water-filled plastic tank, and simultaneously moves a metal contact over one of fourteen cross-sectional drawings. The serial cross-sections are of the human lumbar region at one-half inch vertical intervals. The vertical position of the source in the water is made to correspond with the appropriate cross-section, and the entire system is aligned in three dimensions relative to the position of a scintillation detector.

The areas of the cross-section which represent left and right kidney, muscle, liver, and major blood vessels are drawn with metallic paint. Each organ area is a part of an individual scaling circuit, which is activated by the moving metal contact. In this manner, a summation of each organ's activity in a cross-section is automatically registered. The three-dimensional counting rate is determined by graphically integrating the results from the fourteen cross-sections. The final units, in counts cm^3 per μc sec are adequate for the evaluation of various collimator designs. The counting rate in counts per second can be determined, if data concerning the relative tissue I^{131} concentrations present *in vivo* at any one time are known.

29. *Neutron Capture Therapy of a Cerebellar Hemangiosarcoma Following Surgical and Radiological Treatment.* **Lee E. Farr and Lucas Y. Yamamoto, (Medical Department, Brookhaven National Laboratory, Upton, New York).**

Neutron capture therapy was used to treat a 12 year old patient with a sarcoma of presumed vascular origin located in the cerebellum. The patient had previously been treated with surgery followed by recurrence and by x-ray which did not appreciably retard the tumor growth. Severe respiratory dysfunction developed presumably arising from effects of the neoplasm in the respiratory center. When admitted to Brookhaven National Laboratory Hospital

a large subcutaneous tumor could be palpated from the mid cervical line to the angle of the mandible. Other nodes shown to be neoplastic could be palpated. Treatment was carried out with exposure of limited parts of the neoplasm followed by biopsy so effects could be better evaluated. General effects were encouragingly good. The patient was near extremis on admission but following treatment improved for several months, finally succumbing approximately 8 months after admission. Discussion will be concerned with histologic demonstration of biopsies, dosimetric estimations, control of the tumor, selective effectiveness and complications of the procedure. This is the first treatment of an intracranial neoplasm other than glioblastoma multiforme by this procedure.

30. *Anemia of Nontropical Sprue Studied With Radioiron and Radiochromium.* Emilio R. Giuliani, Albert B. Hagedorn, Charles A. Owen, Jr., and Harold H. Scudamore, (Mayo Clinic and Mayo Foundation Rochester, Minnesota).

Seventeen patients with nontropical sprue were found to absorb only about half the normal amount of an orally administered, standardized dose of iron labeled with Fe^{59}. Twenty-two control subjects absorbed an average of 43 per cent (range 20 to 80 per cent) of a 50-microgram dose. The patients with sprue absorbed an average of 18 per cent (range 1 to 35 per cent). The amount of iron absorbed did not appear to be related to the clinical severity of the disease, to the concentration of hemoglobin in the blood, or to the concentration of serum iron.

Further studies were carried out on six patients using radiochromium and radioiron simultaneously. Erythrocyte-survival rates, measured with Cr^{51}, were uniformly normal. However, two of the patients exhibited significantly more Cr^{51} in the feces than normal; this was interpreted as intestinal hemorrhage to the extent of 7 to 8 ml daily on the average. No gastrointestinal lesions could be demonstrated to account for the bleeding.

Despite their anemia and malabsorption of iron the patients with sprue converted slightly less than the normal amount of plasma iron into erythrocytic iron. This suggests that a maturation defect in the marrow may have contributed to the anemia.

31. *Therapy of Polycythemia Vera with Radioyttrium (Y^{90}).* Joseph Greenberg, Arthur Sawitsky, H. C. Dudley, Robert Levy, and Kanti R. Rai, (Division of Nuclear Medicine, The Long Island Jewish Hospital, New Hyde Park, N.Y.).

Greenberg and Dudley have shown that radioyttrium (Y^{90}), with low carrier content (0.05 mg/Kg Y^{89}), chelated with an excess of N'hydroxy ethylenediamine triacetic acid, when administered intravenously, is deposited *selectively* in the skeleton. The energetic β-emission (maximum 2.2 mev) irradiates the adjacent marrow, causing preferential destruction or at least a marked reduction in its potential to produce immature or bizzare forms of the cellular elements of the blood. The results of clinical trials in leukemia and preliminary data in polycythemia vera were reported at the sixth Annual Meeting of this Society in June 1959.

This paper extends the investigations in polycythemia vera and gives additional data. Thus far, we have treated nine patients with this malady (ages 51-84). The majority manifested considerable organomegaly, had become essentially resistant to other modalities such as P^{32}, and were now difficult to control, even with frequent phlebotomies.

Following administration of a single dose of the chelated Y^{90} (0.1-0.25 mc/Kg) there was a graduated fall in the erythrocyte count, hemoglobin and hematocrit with stabilization in the normal range within a 3 month period. The peripheral white cell and platelet counts after transitory declines showed prompt spontaneous recovery to normal levels. Organomegaly was significantly reduced in all the patients. They remained ambulatory throughout and experienced no untoward reactions. Remission has continued in each of the patients to date, the first case having been treated over one year ago.

32. *Evaluation of Portal Circulation by the Use of Percutaneous Splenic Isotope Injection.* **Robert H. Greenlaw and Seymour I. Schwartz, (Departments of Radiology and Surgery, University of Rochester Medical Center, Rochester, New York).**

Following percutaneous, splenic injection of isotope tracer compounds, circulation times to the liver and to the right heart area measured simultaneously by twin scintillation probes.

The relative appearance times, slope of curves and magnitude of peaks afford a clear appraisal of portal circulation. Splenoportography and measurement of splenic pulp pressure have been carried out in association with the isotope studies and the correlation is excellent.

The comparison of isotope circulation patterns to the liver and the heart is suggested as an addition to the diagnostic work up of a patient with suspected portal hypertension. The technique is adaptable as a screening procedure and perhaps, subsequent to further investigation, as a replacement for the more expensive and complex splenoportography.

33. *Experimental Studies for Scintillation Scanning of the Pancreas.* **Robert H. Greenlaw and William H. Strain, (Department of Radiology, University of Rochester Medical Center, Rochester, New York).**

Screening studies have been carried out in rats on substances designed to make scintillation scanning of the pancreas possible. Per cent distribution of tracer compounds in pancreas, stomach, spleen, liver, kidney, and thyroid were determined routinely at half-hour intervals during 2-3 hours after administration via tail vein. Zn^{65} chelates with amino acids offer promise, but I^{131} derivatives of a variety of organic acids and phenols have been uniformly unsatisfactory. With many of the radioiodine compounds the unexpected accumulation of activity in the stomach was so high that this organ became a major site of concentration. Profiles of the distribution of a variety of zinc chelates and iodine compounds will be presented.

34. *A Focusing Collimator for Research in Scanning.* **J. E. Francis, C. C. Harris, and P. R. Bell, (Oak Ridge National Laboratory, Oak Ridge).**

The gamma ray counting conditions for determining the distribution of isotopes in patients are usually much less favorable than those encountered when scanning a thyroid gland. In order to overcome these disadvantages, several focusing collimators for scintillation counters were developed.

The difficulty is due to having to locate low activity sources in the presence of high activity sources of body background. The background can be reduced by increasing the shielding. However, in order to keep the weight and size to a minimum, it is desirable to use a better shielding material than lead. The septa of a focusing collimator should be made of the most efficient material that is available to maintain both good resolution and high efficiency. Collimators made of a combination of gold and tungsten give the best results so far.

Results of laboratory and clinical tests will be presented that show this collimator justifies the increased fabrication costs by superior performance which yields:

1. Lower background, therefore a better signal to background ratio.
2. It is now practical to scan using gamma rays of higher energy; this increases the number of useful isotopes.
3. Decreased dose lowers cost of pharmaceuticals.
4. Decreased inpatient time lowers hospital costs.
5. Increased resolution will yield better and easier diagnosis.
6. Versatility will mean more measurements, thus lowering overall costs.

35. *Recent Advances in Scanning Equipment.* C. C. Harris, J. E. Francis, Jr., P. R. Bell, D. P. Hamblen, and H. O. Eason, (Oak Ridge National Laboratory, Oak Ridge).

Continued clinical and laboratory tests of scanning equipment have revealed several inadequacies of present-day scanning systems. Scanners often are incapable of carrying heavy detector assemblies with safety and with accuracy of speed and position. Recording and data presentation systems generally do not make good use of available information. Pulse counting systems are often unreliable and lack aids for proper operation and adjustment.

Several new advances in scanning equipment have been developed and tested in clinical practice in an attempt to remove, as much as possible, the above mentioned and other shortcomings. Among these advances are a multiplane scanner capable of carrying heavily shielded collimators with high accuracy of speed and position. There have been developed an improved version of photoscan recording and an improved mechanical printer. The ORNL Medical Spectrometer has been modified to provide "Tuning-eye" adjustment for speed and accuracy of setting and to provide higher stability and reliability. Tape recording of scan data with automatic rescanning playback has been accomplished.

The system and its performance will be described.

36. *A Half-Life Demonstrator.* R. L. Hayes, (Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge).

Abbreviated courses in the use of radioisotopes require laboratory procedures that consume a minimum time but also provide dramatic demonstrations of the principles being illustrated. A half-life demonstrator involving an ion exchange separation of $Ba^{137}m$ ($t_{\frac{1}{2}} = 2.5$ minutes) from Cs^{137} has proved very effective in laboratory exercises at the Medical Division.

37. *An In Vitro Procedure for Screening Intrinsic Factor Concentrates.* Walter Henderson, Nelson Bowser, Paul Heller, and with the technical assistance of Joaquina Greene, (Radioisotope Service, Veterans Administration West Side Hospital, Chicago).

Until recently, all intrinsic factor concentrates had to be assayed for potency by the classical reticulocyte response to oral intrinsic factor concentrates administered together with vitamin B_{12} in patients with pernicious anemia. This method required the use of PA patients in relapse, was time consuming, and limited the number of preparations that could be tested. The use of the Schilling test has been proposed for comparing intrinsic factor concentrates with a standard preparation. This method removes the necessity of using PA patients in relapse, and is less time consuming. However, it does require the administration of radioactive vitamin B_{12} to patients with the accompanying limitation on the number of assays that can be made.

The reported *in vitro* procedure uses rat liver homogenates incubated simultaneously with radioactive vitamin B_{12} and intrinsic factor at 0° C. The resulting binding of the radioactive vitamin to the homogenate, although likely a pure physical phenomenon, can be used to compare the potencies of unknown intrinsic factors with that of a standard preparation. It has been found that the results, although not necessarily quantitative, can be used as a screening procedure for the qualitative separation of those intrinsic factor concentrates that should be further tested by the Schilling test.

The results of a comparison between reticulocyte response, Schilling test data, and *in vitro* test studies will be shown for seven intrinsic factor concentrates.

38. *The Accumulation of Radioactive Substances on Glass.* **CHARLES J. HLAD, M. ERVIN, AND HAROLD ELRICK, (Radioisotope Service, Veterans Administration Hospital and General Rose Memorial Hospital, Departments of Medicine and Pharmacology, University of Colorado School of Medicine, Denver).**

We have shown that the accumulation of certain radioactive compounds on glass is greatly increased when these compounds are used at high specific activities and low concentrations. These findings suggested a need for a more detailed study of other radioactive compounds as well as the phenomenon itself. In order to do this, we have devised the following system. The radioactive compound (in solution) under study is circulated at a constant rate through a specially designed fritted glass apparatus in a well counter, connected to a scaler and digital printer. Thus a continuous and sensitive measure of the accumulation of the radioactive material on a large glass surface is obtained.

This accumulation is an exponential function of time, and the resulting data may be analyzed for a specific rate constant, and the percentage accumulation on the fritted glass surface. Studies have been done using the following radioactive materials: I^{131}, P^{32}, Na^{22}, human serum albumin-I^{131}, insulin-I^{131}, and 1-tri-iodothyronine-I^{131}. The influence of specific activity, pH and concentration of other ions has been studied. Accumulation was observed with all materials at high specific activities except Na^{22}. The most accumulation was observed with insulin-I^{131} and 1-tri-iodothyronine-I^{131} and the least with I^{131} and P^{32}. Lowering of the specific activity decreased accumulation. The accumulation of some of the materials was affected by pH. The method not only measures the amount of accumulation, but is extremely useful in finding means of preventing accumulation.

39. *Bile, An Inhibitor of Vitamin B-12 Absorption.* **W. L. HONSKA, T. B. DRISCOLL, AND P. C. JOHNSON, (Radioisotope Service, Veterans Administration Hospital, and Department of Medicine, University of Oklahoma, Oklahoma City).**

Though vitamin B_{12} is readily dialyzible, physiological absorption in the small intestine requires intrinsic factor activity. Something may exist in food or intestinal secretions which inhibits, perhaps by binding, passive absorption of B_{12} by dialysis. Fasting of gastrectomized or PA patients does not increase B_{12} absorption, so it is possible that intestinal secretions themselves inhibit B_{12} absorption. Bile binds B_{12} but it is not known whether this binding inhibits absorption. Using an *in vivo* rat assay, we have estimated B_{12} absorption by instilling .03 μgm of $Co^{60}B_{12}$ into the duodenum and measuring liver radioactivity 6 hours later. The duodenum is ligated just above or below the bile duct to free the intestine of bile and/or gastric juice. Using groups of 20 rats, the upper tie control liver uptake was 270 $\pm$ 20 counts per minute (mean $\pm$ SE) and 500 $\pm$ 18 for those with a lower tie. Instillation of 0.5 ml of rat bile, to rats with a lower tie reduces the control to 367 $\pm$ 34, but gastric juice 0.5 ml plus 0.5 ml bile returns this to control values 521 $\pm$ 22. Gastric juice instilled into those with an upper tie increases uptake to 418 $\pm$ 22, a value similar to the lower tie control while addition of bile decreases it to 175 $\pm$ 14. We conclude that bile in the small intestine inhibits B_{12} absorption and absorption can be returned to normal by addition of whole rat gastric juice. Intrinsic factor activity is necessary to prevent bile from inhibiting B_{12} absorption.

40. *Practical Application of Neutron Activation Analysis for the Determination of Protein Bound Metals in Blood Serum.* A. Jacobson, S. Brar, T. Fields, I. G. Fels, E. Kaplan, P. Gustafson, and Y. T. Oester, (Radioisotope Service, Veterans Administration Hospital, Hines, Illinois and Argonne National Laboratory, Lemont, Illinois).

This laboratory has endeavored to initiate a program for the routine analysis of protein bound metals in blood serum utilizing the CP-5 reactor at Argonne National Laboratory (A.N.L) and single and multichannel analyzing equipment.

Successful efforts were made in effectively removing distracting contaminants such as sodium and potassium by means of dialysis. Comparisons of electrophoretic patterns before and after dialysis demonstrated little or no distortion of these patterns.

Containers for irradiating samples were investigated with the purpose of providing minimal contamination of the serum sample, minimal radiation levels after activation exposure, and maximum convenience.

Irradiation times were calculated and empirically determined for the maximum sensitivity for the detection of copper. Sample counting times were adjusted for maximum accuracy and convenience permitting results to be obtained in less than 3 hours from sample preparation to final analysis. Copper levels of less than 10^{-9} g/ml serum were able to be quantitated.

The procedure, results, conclusions, and the varied practical applications of this technique will be given as an accomplished routine operation and not as a theoretical discussion.

41. *Observations on the Disappearance of Labelled Albumin Injected Intra-articularly.* Sten Jacobsson and Arnold Feldman, (Halsted Laboratory for Experimental Surgical Research, and Radiology Department, University of Colorado Medical Center, Denver).

It has previously been established that large molecules, such as serum proteins, leave joint spaces only by way of lymphatics. In order to study the removal of such molecules from joints we have injected radio-iodinated human serum albumin into the knee joints of dogs.

The leg into which injection was made was attached to the rim of a wheel which could be moved at a variety of speeds. External counting over the knee joint was performed, and lymph samples were collected from the cannulated thoracic duct. At varying intervals blood samples were drawn. The samples were assayed for radioactivity.

During rest the disappearance of activity from the joint is very slow, but increases with movement. If identical cycles of movement and rest are performed successively in the same animal, the collected activity for each cycle is very nearly the same.

Possible clinical applications of this method will be discussed.

42. *A Total Body Scanner.* H. E. Johns, J. Cederlund, and D. Rotenberg, (Ontario Cancer Institute, Toronto).

A total body scanner, using a 5 inch $\times$ 2 inch high sodium iodide crystal and a 5 inch photomultiplier tube has been constructed.

The crystal is protected from background radiation by a lead shield weighing about 1500 lbs. The honey cone collimator has 37 hexagonal tapered channels 5 inches long. The effective focus measured in a water phantom is at a distance of 9 cm from the end of the collimator. This detector head is arranged to move in two directions at right angles beneath a prone patient.

A synchronously moving plotting unit produces two different pictures of the distribution of radioactivity within the patient. One is obtained by means of an electrical stylus which produces a mark on a sensitized paper for a preset number of pulses. The other is produced by exposing a film to the light from a small lamp, the brightness of which is controlled by the counting rate. The contrast of the film can be controlled by giving the lamp a suitable bias voltage.

43. *The Radioisotope Renogram: Optimal Equipment, Techniques, and Test Agent.* **D. E. Johnson, G. V. Taplin, J. Hayashi, and E. Dore, (University of California at Los Angeles, School of Medicine, Departments of Biophysics-Nuclear Medicine, Radiology, and Medicine, and the Los Angeles County Harbor General Hospital, Torrance, California).**

The value of the Radioisotope Renogram as a routine diagnostic procedure has been enhanced by using a more efficient arrangement of the detection equipment, by a quantitative *in vivo* measurement of the *rate* of urinary excretion of tracer, as a more sensitive index of overall renal function and by a new test agent having ideal physiological features.

Phantom studies were made to select the optimal physical factors for obtaining reliable Renograms in spite of minor misplacement of the renal detectors. The effects of varying the aperture size of the probes, the amounts of crystal retraction in the cylindrical collimators, the depth of the kidneys in the phantom and the distance beween the kidneys were determined in respect to the efficiency of measuring renal radio-activity in a high body background. In addition, the effects of gross misplacement of the detectors and the use of lead filters to reduce body background radioactivity were evaluated.

Previous work showed that the per cent trace excretion in 30-minute urine samples was a more sensitive index of overall renal function than either the tracer blood clearance rate or the standard 30-minute PSP test. Such tracer excretion data aided interpretation of individual renal tracings. Therefore, a quantitative technique for measuring urinary excretion rates *in vivo was* developed. This procedure avoids the hazards of catheterization, obviates errors from incomplete urine collection and provides a more sensitive index of total renal tubular function.

Hippuran I^{131}, which has the most rapid tubular cell turnover rate of all urographic test agents, gives symmetrical Renograms with sharply separated vascular, tubular and excretion segments. Its more rapid renal accumulation and urinary excretion rates are reflected in the Renogram by more steeply rising and falling tubular and excretion segments than are obtained with other test materials. Thereby its use increases the sensitivity of the Renogram for registering abnormalities of tubular function and partial upper urinary tract obstruction.

44. *Enhancement of Therapeutic Effectiveness of P^{32} Labeled Polymetaphosphate by Oral Estrogens in Carcinoma of Prostate Metastatic to Bone.* **E. Kaplan, I. G. Fels, and J. J. Imarisio, (Radioisotope Service, Veterans Administration Hospital, Hines, Illinois).**

The use of P^{32} labeled polymetaphosphate has demonstrable palliative effect in treatment of metastatic carcinoma of prostate to bone. More recent observations suggest an enhanced palliation when polymetaphosphate is combined with estrogen therapy. In the specific regimen under consideration, a small series of patients were treated with two millicuries of polymetaphosphate three times per week, administered intravenously, for a total of sixteen millicuries. This dosage was preceded by, accompanied with, and followed by twelve milligrams of TACE b.i.d.

In the group so treated with the combination therapy, palliation of pain appeared more complete and persisted for a longer period of time. Remarkable decrease in elevated acid phosphatase values was observed as well as decrease in alkaline phosphatase values. Three individuals in the group treated were paraplegic secondary to metastases to the vertebrae, one showed complete remission and two showed partial remission of these symptoms. Although increased survival has not been conclusively demonstrated, it is the impression of the authors that such is the case. Hematopoetic depression was minimal in those cases studied.

A program is currently in progress to demonstrate with statistical validity the effectiveness of P^{32} labeled polymetaphosphate used with estrogen as compared to estrogen alone. Influence of these therapeutic agents upon mortality and morbidity will be determined in the two groups.

45. *Clinical Value of the Plasma-Iron Turnover Rate in the Diagnosis and Treatment of Polycythemia.* **Joseph M. Kiely, Charles F. Stroebel, David G. Hanlon, and Charles A. Owen, Jr., (Sections of Medicine and Biochemistry, Mayo Clinic and Mayo Foundation, Rochester, Minnesota).**

The plasma-ion turnover rate (PITR) is a useful index of erythropoiesis. Patients with polycythemia vera have increased erythrocyte production and have elevated values for PITR. Early in the course of polycythemia vera some patients may have only an equivocal increase in red cell mass associated with a low plasma volume. Patients with so-called relative polycythemia (normal red cell mass with a chronic reduction in plasma volume resulting in a pseudopolycythemia) have normal erythrocyte production and have been reported to have normal values for PITR. Patients in this latter group are frequently thought to have polycythemia vera because of increased hematocrit readings and hemoglobin concentrations. The differential diagnosis is important because therapy and prognosis are entirely different in these conditions.

Thirty-eight patients were studied to evaluate the practical value of the PITR in making this distinction. In 34 of these 38 the PITR clearly indicated whether the patient had polycythemia vera or relative polycythemia. In two of the three patients with polycythemia vera in whom the NITR was only equivocally elevated, the concentration of plasma iron was quite low owing to multiple phlebotomies.

Of special interest were seven patients in whom a definite diagnosis could not be made on the basis of clinical findings and blood-volume data. The PITR in six of these patients indicated clearly that they had relative polycythemia.

A normal PITR in four patients with polycythemia vera in remission aided in the decision to withhold further therapy.

46. *High Dose Effects of Total Body Irradiation As Observed in Accidental Exposures and Attempted Repression of Immune Response.* **Ralph Kniseley, (Eden Hospital, Castro Valley, California).**

The effects of high dose radiation exposures are available from (1) a few criticality accidents, (2) patients with leukemia or advanced malignancy, (3) patients prepared for organ transplants. Main concern focuses on: causes of death, general tissue and cellular response, and principally lesions of the blood forming and lymphatic organs, gastrointestinal tract, and gonads. Secondarily the fate and effect of marrow grafts, and late delayed sequelae are of concern.

47. *Training Aids.* **Ralph M. Kniseley, (Eden Hospital, Castro Valley, California).**

In teaching nuclear medicine, success depends on laboratory exercises that use imaginative aids, either simple or elaborate. Audio-visual aids include film strips, wall-mounted diagrams, and movies. More sophisticated devices such as three-dimensional models, manikins, electronic "bread boards" have proven valuable in ORINS courses.

48. *Thyroid Stimulation and Suppression Tests.* **C. T. Knorpp, M. H. Rennie, and D. R. Korst, (Radioisotope Service, Veterans Administration Hospital, Ann Arbor).**

Thyroid stimulation and suppression tests have been performed for the past three years on all patients whose I^{131} thyroid function tests have fallen outside our normal range of 12-40 percent. In addition to these patients, we have also included a group who had signs of clinical hyper- or hypothyroidism but who showed repeatedly normal I^{131} uptakes.

Approximately 70 patients received thyroid stimulating hormone (TSH) given as 10 units daily for 2 or 3 days with a repeat uptake on the following day. All counts were done with a scintillation spectrometer at 2, 6 and 24 hrs. to establish an uptake curve. The usual euthyroid

response was an increase of more than 100 percent in uptake values. A high percentage of false hyperthyroidism was detected by this test, while two subjects were found to have pituitary tumors. The effects of iodine contamination will be discussed.

Approximately 50 patients with uptakes elevated (above 40 percent) received tri-iodothyronine (T3) as 100 μg by mouth each day for 4 or 5 days. Hyperthyroid patients showed no change. Several patients with clinical hyperthyroidism and borderline high uptakes showed a marked increase in uptake following T3. Many euthyroid patients with borderline elevated values showed satisfactory suppression of uptakes, usually a 50 percent or greater decrease in values.

It is our experience that a repeat uptake following TSH stimulation or T3 suppression in the patient with borderline uptake values and clinical findings is as valuable as any battery of thyroid tests. TSH for 2 days or T3 for 4 days appear to be adequate for stimulation or depression.

49. *Goldfish and Yeast Experiments.* **Granvil C. Kyker and Fred Snyder, (Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge).**

Simplified exercises were designed as training aids to illustrate certain basic principles in the use of radioisotopes. The procedures are conveniety adaptable to individual participaton in brief laboratory periods and require minimal facilities, operational steps, and contamination hazards. All materials and apparatus are dispensed on 12″ x 18″ flat enamel tray placed on a 24″ x 30″ protective absorbent mat. This arrangement serves as the entire working space for all operations except transporting samples to a counter. The goldfish and yeast experiments are examples that illustrate concepts of specific activity and of biological incorporation. The partition of Na^{22} between *fish* and *pool* as a function of saline concentration illustrates the effect of specific activity on tracers. The use of P^{32} in a yeast culture permits a rapid demonstration of biological incorporation as well as the effect of various factors such as temperature, pH, irradiation, and nutrition.

50. *The Hepatic Removal of Cr^{51} Labeled Endotoxin From the Circulation of The Rabbit.* **Dieter Koch-Weser, William J. MacIntyre, John R. Moses, and Ralph L. Schapiro, (Department of Medicine, Western Reserve University, School of Medicine, Cleveland).**

In the course of studies on the mechanism of endotoxin activity it became important to find reliable methods to investigate its clearance from the circulation and its uptake by different organs and functional units such as the reticulo-endothelial system (RES).

By cannulating a carotid artery in the rabbit and leading the cannula through a scintillation counter into the opposite jugular vein, clearance from the blood of intravenously injected Cr^{51} or I^{131} labeled compounds was continuously observed. This was correlated with the uptake and disappearance rates obtained by external counting over liver, lung and vascular pools as well as *in vitro* assays of fluid samples and organs. I^{131} Rose bengal and tetra-iodophenolphthalein were used to standardize the method with substances taken up by the polygonal cells in the liver and excreted into the intestine, while colloidal Au^{198} clearance was investigated as an indicator of RES activity and blockage.

Endotoxin (lipo-polysaccharide from E. coli) labeled with Cr^{51} was found in the normal rabbit to be taken up by the RES. This uptake could be activated by stimulation of and inhibited by blocking of the RES. In rabbits made tolerant by previous endotoxin injections, labeled endotoxin is precipitated by antibodies and the antibody-endotoxin complex is largely and rapidly trapped in the lung, slowly released from there and taken up by the RES.

To validate the Cr^{51} label, uniformly C^{14}-labeled endotoxin was also used. This was produced by growing E. coli on C^{14}-glucose containing medium and preparing the lipo-polysaccharide from the labeled organisms.

51. ***Endocrine Binding of Radio-Cobalamine.*** **Henry Lanz and Joseph R. Rubini, (Radioisotope Service, Veterans Administration Hospital, Dallas).**

Several recent studies of Co^{60} labelled B_{12} body distribution have reported significant retention of Co^{60} activity by pituitary and adernal tissues. The evidence available indicates that this activity is due to the presence of cobalamine itself, and not to its metabolic products, or to Co^{60} ions. These observations were the basis for the present studies, in which endocrine tissue homogenates were used to evaluate *in vitro* binding; organ assays were made after *in vivo* injection of $Co^{60}B_{12}$. Both technics yielded essentially similar results. Pituitary and parathyroid tissues consistently showed a high binding capacity for the labelled vitamin. This binding capacity was of the order of 2 to 20 times that of other endocrine tissues and liver, irrespective of the experimental conditions used, or the animal (beef, hog, dog, and rat). The evidence suggests that vitamin B_{12} may play an important role in pituitary and parathyroid metabolism.

52. ***Intragastric Beta Radiation Therapy with Radioactive Ruthenium-Rhodium-106 in Patients with Duodenal Ulcer.*** **Armand Littman, Benum W. Fox, and Raymond Teplitz, (Department of Medicine, University of Illinois College of Medicine, Chicago, and Veterans Administration Hospital, Hines, Illinois).**

The partial succes of x-ray treatment in suppressing gastric acid secretion in patients with peptic ulcer has led to a search for ways to improve the results. The intragastric application of beta-emitting isotopes in dogs has been reported favorably. We have previously reported results with Sr^{90} and Ru-Rh^{106}.

Our technique is apparently the first described for use in man. A brass cylinder 6 mm in diameter and 18 mm long was electroplated with 100 mc of Ru-Rh^{106}. The cylinder was affixed to a slide wire and encased in a steel shield attached to a thin flexible shaft. A rubber balloon enclosed the irradiation unit, inflatable from the operating end of the instrument.

The unit was easily passed into the stomach in the manner of an Ewald tube, and the balloon inflated with 525 cc of air. Treatments lasting several hours were well tolerated, with frequent momentary fluoroscopic checks.

The surface dose at 5 cm from the center of the source was 9.5 rep/min.

Six patients were given doses ranging from 200 to 800 rep in single treatments and one was given a total of 1000 rep in two treatments on consecutive days.

There were no side effects. In smaller doses there was no significant effect on acidity although gastritis was evident on biopsy. Three patients receiving 600, 800 and 1000 rep developed large gastric ulcers which healed slowly and required partial gastrectomy. Only transitory and minimal changes in gastric acidity were observed.

Single treatments by our method thus failed to decrease acidity although doses were large enough to produce severe damage. At present we are attempting to improve dosage distribution, and to find out whether the necrotizing effects can be minimized by dosage fractionization.

53. ***Accidental Exposure to Partial Body X-Irradiation.*** **David I. Livermore, (Aerospace Medicine Division, Office of the Surgeon General, USAF, Washington, D.C.).**

A narrative report including the clinical responses will be given on a recent accidental exposure, rather high level partial body x-irradiation from klystron tubes at one of the USAF radar sites.

54. *Whole Body Retention of I^{131} as a Means of Appraising Human Thyroid Function.* **C. C. Lushbaugh, D. B. Hale, and P. S. New, (Los Alamos Scientific Laboratory, University of California, Los Alamos).**

Thyroid I^{131} uptake was measured in patients by the conventional small collimated crystal detector and compared with the whole-body retention of 3 μc of oral NaI^{131} measured with both a 9 x 6 in. crystal detector and a large well-type liquid scintillator. This comparison revealed that per cent whole-body retention of the oral tracer dose after 48 hours was an accurate measurement of thyroidal binding of iodine. The large liquid scintillator, into which the entire patient was placed for assay, was affected less by geometric variations caused by the size and shape of the patient than the crystals, which required daily positioning. The results obtained with the 9 x 6 in. crystal correlated better with those obtained with the liquid scintillator than those from the small collimated crystal. Only one tenth to one half of the radioactivity commonly used clinically was required for consistent reproducible whole-body retention measurements. Only 200 seconds of counting time was required on three successive days for an appraisal of thyroid function by this method.

In addition to data comparing the results obtained by the three different radiation detectors, whole-body retention lines illustrative of hyper-, normal, hypo-, and no thyroid function will be presented.

55. *The Use of Radio-Cholografin in Cardiovascular Studies.* **William J. MacIntyre, Godofredo Gomez Crespo, and James H. Christie, (Radioisotope Laboratory, Highland View Hospital, Cleveland).**

Cr^{51} tagged red cells and I^{131} human serum albumin have been used for both dynamic circulatory studies and static measurements such as blood pool scanning. The amounts administered have necessarily been limited because of the slow metabolic turnover resulting in long radiation exposure to the patient. Very fast circulatory measurements have been made with rapidly clearing materials, however, their use has been limited for investigations requiring reasonable stability in the vascular system for periods of ten minutes to one hour.

In such problems as the delineation of the heart or other vascular pools by the use of automatic scintillation scanning, it is necessary that the administered substance remain in the circulating blood without appreciable loss for almost one hour. Thereafter, rapid excretion is desirable to minimize total body dose.

Radio-Cholografin (Radio-Iodinated (I^{131}) Iodipamide Sodium®-Squibb) has been utilized in the scanning of vascular pools to reflect the more rapid circulatory changes of cardiac output and peripheral vascular flow. The disappearance from the blood of Radio-Cholografin and I^{131} human serum albumin will be compared.

Experimental data will be shown which demonstrates that larger doses of Radio-Cholografin can be administered and while yielding the desirable increase in counting rate will result in a lower radiation exposure to the patient.

56. *Radioisotope Evaluation of the Pulpless Tooth Problem.* **F. James Marshall and J. R. Trott, (Departments of Oral Histology and Oral Pathology, Faculty of Dentistry, University of Manitoba, Winnipeg, Canada).**

The study was undertaken to test two important procedures used in the treatment of pulpless teeth. The procedure of filling the empty pulp canal and the ability of this filling to seal the canal. The procedure used in sterilizing the dentin and the effect of this treatment on the permeability of the dentin.

At present only clinical x-rays are used to evaluate the seal of pulp canal fillings. Dentin permeability has been studied only in relation to the tooth crown and not the root.

The "pulpless" tooth has long been looked on with disfavour and scepticism by many physicians and dentists; the unknown always is. The terms "dead tooth" and "non-vital tooth" have served to engender this feeling. If these teeth were actually dead or non-vital, they could be extracted painlessly or more likely they would be sequestrated.

Experimentally it has been shown that the root covering (cementum) is a barrier to the spread of agents used in the canal. Thus, if treatment is confined to the canal and the canal is completely obturated, only the very end of the canal opening (less than 1/10 mm in diameter) presents a reactive surface to the body. The materials used for these fillings are not irritating to body tissues. By blocking the flow of oral contaminants through the root canal to the tissues surrounding the tooth and by eliminating the toxins of the pulpal degradation, *it can be considered possible for the body to maintain a pulpless tooth in health.*

Extracted human teeth were treated or filled using typical clinical methods. These procedures were tested by applying solutions of radioisotopes internally in the tooth and recording the pathway of the isotope penetration with autographs. The tracers penetrated the dentin and the filling margins or apical canal seals to various degrees depending upon the treatment used.

RESULTS: 1. S^{35}, as sodium sulfate, proved to be the most efficient tracer although I^{131}, as sodium iodide, was the deepest penetrator. 2. Root dentin varies in normal permeability and this permeability could be altered by treatment. Premeability was increased by H_2O_2 + Hypochlorite irrigations and decreased by H_2SO_4 + Bicarbonate of soda irrigations prior to filling. 3. The root covering (cementum) acted as a barrier to the spread of solutions that penetrated the dentin from the pulp canal. 4. Absolute root canal seals were possible under the conditions of this experiment. 5. The various commonly used methods of sealing were evaluated and graded.

57. *A New Approach to the Measurement of Body Fluid Constituents: Determination of Plasma Sulfate Using Radioactive Barium (Ba^{133}).* E. MILLER, C. J. HLAD, J. H. HOLMES, AND H. ELRICK, (Radioisotope Service, Veterans Administration Hospital and Departments of Medicine and Pharmacology, University of Colorado School of Medicine, Denver).

Inorganic sulfate measurements may be used clinically, but there is no method suitable for quantities usually present in blood. We have developed a new method using Ba^{133} which is sufficiently sensitive for the purpose.

Protein is precipitated from 2 ml of plasma by the addition of 4 ml of uranium acetate. Two ml of a $BaCl_2$ solution containing Ba^{133} of known specific activity is added to 2 ml of plasma filtrate. The concentration of barium is approximately 50 percent in excess of the sulfate expected. The solution is allowed to stand 4 hours at 5° C, and then centrifuged. The activity of 2 ml of supernatant is determined simultaneously with the activity of 2 ml of the original $BaCl_2$ solution. From these measurements plasma sulfate concentration is calculated.

The method has been used to measure plasma sulfate in 42 normal females and 45 normal males, The mean plasma sulfate level in the females was 0.64 ± 0.20 mEq/L, and in the males, 0.65 ± 0.14 mEq/L. Plasma sulfate was also measured in 62 patients in renal failure before and after artificial kidney dialysis. The mean plasma sulfate before dialysis was 7.52 mEq/L. After dialysis it was 2.66 mEq/L. With slight modification, the method was used to measure urinary sulfate on a variety of hospital patients. Twenty-five single specimens from 14 patients had a range of 4.3 to 81.5 mEq/L. Nineteen 24-hour collections on 11 of these patients gave total excretions of 14.7 to 50.2 mEq. with a mean of 27.41 mEq.

The technique is simple, practical and reproducible. It is suggested that the principle of measuring a body fluid constituent by combining it with an easily detectable radioisotope may have wider application.

58. *Dosimetry of Total Body Radiation: (a) Physical Dosimetry, (b) Chemical Dosimetry.* A. C. MORRIS, RAYMOND L. HAYES, (Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge).

(a) A Total-Body Irradiation Facility for human subjects was recently completed at the ORINS Medical Division. An array of eight 500-curie Cesium-137 sources provides a maxi-

mum exposure rate of 300 r/hour. Exposure rate may be attenuated in 31 discreet steps, by means of metallic filters interposed in the beams, down to a 1.8 r/hour rate.

(b) Depth dose as a function of body size is being studied with the aid of compartmentalized phantoms. Those phantoms have been designed to simulate a standard adult, an adolescent, and a child. Chemical dosimetric measurements of the integral and average dose are also being made. In addition we plan to make studies of the gamma rayspectrum utilizing low-activity mock-therapy sources.

59. *ORINS Electronic Breadboard.* A. C. Morris, Jr., (Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge).

The ORINS Electronic Breadboard is a training aid that allows the experimenter to construct, with jumper leads, some basic electronic circuits. Through a series of 17 successive experiments the student finishes the breadboard with a working Geiger-counter circuit. Thus the physician can work first-hand with some of the fundamental electronic components and circuits.

60. *EDTA-Cr^{51} γ-ray "Carrier".* William G. Myers and Carl F. Diener, (The Ohio State University Health Center, Columbus).

Radiochromium (Cr^{51}) in the HCl solution obtained from the Oak Ridge National Laboratory is pipeted into a 5 x 30 mm test tube. A 0.010M solution of disodium ethylenediaminetetraacetate is added in about tenfold stoichiometric excess. A highly stable chelated compound forms when the tube is heated 30-45 minutes in near boiling water.

Urine obtained in frequent bladder washings of rats after intravenous injections revealed clearance half-times of only 15-20 minutes. Virtually no radioactivity remained in mice 24 nours after injection.

EDTA-Cr^{51} should find many applications as a γ-ray carrier in "Photon Projection Analysis" for *in vivo* dynamic physiological studies of short duration, e.g., circulation time, cardiac output, and in radiocardiography.

The physical "shelf" half-life of 28 days makes for convenience and economy. The biological half-life is short and radiation exposures are low. Cr^{51} emits no useless and undesirable β-particles, making high the "Photon Merit Ratio" = Useful Signals/Absorbed Energy.

The 323-Kev γ-ray is "seen" efficiently by scintillation detectors. It penetrates soft tissues well, with narrow-beam half-thickness of 6 cm in water. Lead half-thickness of 0.19 cm makes directional shielding facile.

Toxicity of non-labeled EDTA-Cr is extraordinarily low; all mice and rats survive intravenous injection with 100 milligrams of chromium in the chelated compound per kilogram of body weight. This concentration is about a millionfold greater than is required to carry adequate Cr^{51} label at the specific activity that is presently available.

61. *Radioiodine, I^{125}.* William G. Myers and Han C. Vanderleeden, (The Ohio State University Health Center, Columbus).

Radioiodine, I^{125} ($t_{1/2}$ = 60 days) is the longest-lived radioisotope obtainable in specific activity suitable for an *in vivo* tracer of stable Iodine, I^{127}. Each 100 disintegrations is accompanied by 142 "usable" photons: about 8 are unconverted 35.4 Kev γ-rays and 134 are 27.3 Kev X-rays following electron capture and internal conversion.

Broad-bear half-thickness in cheese slices is 2.4 centimeters. Calculated narrow-beam half-thicknesses are: Water, 1.6; Sodium Iodide, 0.018; Copper, 0.0054; and Lead, 0.0015 Cm. A 2-millimeter NaI crystal absorbs more than 99 percent of the photons, and the background is quite low. One millimeter of copper or lead absorbs almost all photons so that shielding is simple, collimators can be light, and directionality is readily achievable.

I^{125} is obtained by the bombardment of tellurium or antimony in a cyclotron. Presumably the wasteful waiting for I^{124} and I^{126} to die away can be largely eliminated when we can

bombard enriched tellurium targets, or by the $Sb^{123}(He^3,n)I^{125}$ reaction. Present cost is compensated partly by the greatly reduced frequencies of labeling procedures and shipping.

Because there are no high-energy β-particles, radiation exposure for a given initial count rate during complete decay of I^{125} in the thyroid gland will be only about 60 percent of that from I^{131}. Also, the rate of exposure will be seven to eight times slower. Lightness of detector makes readily feasible the continuous recording of accumulation rates. A hard γ-isotope may be used for a second uptake study by easily filtering or "tuning" out the I^{125} photon.

62. *Radiostrontium-87m.* WILLIAM G. MYERS, (The Ohio State University Health Center, Columbus).

Radiostrontium-87m ($t_{1/2}$ = 2.8 hours) can be "milked" quickly as it is needed from long-lived Y^{87} ($t_{1/2}$ = 80 hours) by simple chemical procedures. Y^{87} is generated readily by the bombardment of Strontium (preferably highly enriched in Sr^{86} and Sr^{87}) in a cyclotron; and the "cow" easily is separated chemically from the target.

Strontium-87m emits 388 Kev γ-rays during isomeric transition to stable Sr^{87}. About one-fourth of them are internally converted and three-fourths are available to serve as γ-ray "signals" for study of *in vivo* physiologic and biochemical processes.

Obviously, because of greatly decreased radiation exposures, Sr^{87}m is advantageous over long-lived γ-isotopes, such as I^{131}, for acquiring information obtainable in a few seconds, or minutes after injection, e.g., circulation time, cardiac output, various clearances, and radiocardiography.

Turnover rates in bone diseases revealed heretofore by long-lived Sr^{85} ($t_{1/2}$ = 65 days) usually are so rapid that much information sought by the physician is obtainable within one to a few hours. Therefore, replacement of Sr^{85} by Sr^{87}m will result in greatly decreased exposures to radiation. Moreover, valuable information about the dynamics of normal or disease processes may be revealed by the serial administration of Sr^{87}m at intervals as short as about 12 hours, without increase in dosage. The 388 Kev γ-rays emitted by Sr^{87}m can be distinguished easily from the 513 Kev γ-rays of Sr^{85}, so that these isotopes could be used conjointly to study transient changes in bone metabolism superimposed on processes of long duration.

63. *The Radioisotope Renogram: Advances in Procedure.* ROBERT A. NORDYKE, (Radioisotope Service, Veterans Administration Center, and the Department of Medicine, University of California Medical Center, Los Angeles)

As a minimum ideal the radioisotope renogram should provide a rapid, simple method for determining comparative kidney function by external body counting. Since the advent of I^{131} labeled iodohippurate (Hippuran), which is removed rapidly from the blood by the kidneys only, testing time has been shortened and the scintillation probes may be placed directly over the kidneys, perpendicular to the back, thus simplifying probe positioning. However, present collimation systems have not provided routinely reproducible and valid comparisons of kidney function. This has chiefly been caused by an emphasis on placing the probes precisely over the kidneys to increase the "kidney-background ratio," and keeping the crystal close to the skin to decrease administered radioactivity. Both of these factors greatly magnify geometric differences of kidney position and individual contour. In an attempt to minimize these factors, renograms were made by withdrawing the crystal 6 inches from the skin, using no collimation other than a midline lead plate. Such renograms had characteristics similar to the standard, highly-collimated renograms. We therefore designed rectangular collimators 6 inches high and 2½ inches wide at the skin surface which slope back to a 1 inch crystal recessed 6 inches from the skin. This collimation has greatly enhanced simplicity of probe placement reproducibility, and valid comparison of kidney function. Radiation to the bladder wall by the radioactivity used (50 μc I^{131} labeled Hippuran) is approximately 0.02 rad per test.

64. *An Appraisal of As-74 for Localization of Brain Tumors.* **W. PAUL AND E. H. BOTTERELL, (Department of Pathological Chemistry and Department of Surgery, University of Toronto, Toronto).**

A positron annihilation scanner system was used for this study. The apparatus was modified to accentuate mid line localizations in the positrocephalogram on the assumption that lateralized localizations are easily registered by the asymmetrogammagram and the slight disadvantage so produced in the P.C.G. is of no consequence.

One hundred and ninety-five cases are presented, sixty of which were subsequently verified as brain tumors. These cases are classified as to pathological findings and the degree of localization visible in the scan record.

The criteria of the positive finding of this series was such that only a very clearly indicated localization was considered. Because of this no false positive localizations were encountered. Surgery was in fact undertaken in seven cases with the Arsenic scan as the only special investigation and in three others when the Arsenic scan was the only positive investigation in the face of negative air study and arteriogram.

In contrast to findings of Sweet and Brownell, there is a preponderance of negative scans with certain gliomas which may be accounted for by differences in recording method, dosage, and circuitry.

Very high reliability in localization of supratentorial meningiomas rendered negative scans useful in many cases.

65. *Apparent Acceleration of Leukemic Process Following I^{131} Therapy of Hyperthyroidism.* **RICHARD E. PETERSON, (Radioisotope Service, Veterans Administration Hospital, Iowa City).**

Seven cases of acute leukemia following I^{131} therapy of hyperthyroidism have been recorded as being diagnosed prior to December 31, 1956 in treatment groups summarized at the Argonne Conference on Radio-iodine in 1956 and in the U. S. veteran population.

An estimate of the average marrow dose expected with I^{131} therapy to be 10 rad, is based on published measurements of blood radiation dose for 25 hyperthyroid patients. The linear (no threshold hypothesis) for radiation leukemia predicts that an additional 10 rad marrow dose should result in a 20 percent increase in the incidence of leukemia. The incidence of all leukemias after I^{131} in the 16,000 Argonne Conference patients and 1,800 V. A. patients would be predicted to be 6 or 7 cases. Thus, the observed incidence of leukemia in that population appears to be only the natural incidence. However, statsitical validity for either accepting or rejecting this prediction of the non-threshold hypothesis will have to await observing some 200,000 patients for 10 years.

Two other features strongly suggest a relationship between I^{131} therapy of hyperthyroidism and the subsequent development of acute leukemia. The age and sex adjusted rates for acute leukemia (Brooklyn, 1943-52) predict that this same popultaion of patients should contain 2.3 cases of acute leukemia through 1956. Consequently, the observation of 7.0 cases of acute leukemia represents a significant increase in acute cases ($P<.02$). In addition, the latent period between I^{131} therapy and onset of 9 cases of leukemia is 23 ± 7 months. This is significantly shorter ($P<.01$) than the 54-76 month latent periods found with radiation induced leukemias or the average interval for random occurrence of unrelated or natural leukemia. However, similar radiation doses to the marrow of euthyroid patients has not been recognized to be followed by acute leukemia at an interval averaging 24 months. Consequently, the combination of about 10 rad to whole marrow sensitized in some fashion by the hyperthyroid state may be essential to the particular sequence of events in the cases under discussion. The increased proportion of acute leukemias, with the latent interval of 23 ± 7 months, without any increase evident in the total incidence of leukemia can best be attributed to an acceleration of the course in individuals already predisposed to leukemia.

A similar acceleration of the course in predisposed individuals by radiation of hypersensitive marrow in the early post natal years, is suggested in the studies of Stewart, Webb and Hewitt.

66. *The ORINS Linear Scanner in Clinical Diagnosis.* Felix J. Pircher, Marshall Brucer, A. C. Morris, Jr., and Ruth Black, (University of Michigan, Ann Arbor, and Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge).

The ORINS linear scanner for whole-body scanning represents an elaboration on the earlier instrument of Dr. E. E. Pochin. The instrument has a long narrow area of sensitivity that is oriented transverse to the body axis. The record obtained is a contour showing the varying amounts of radioactivity contained in the transverse sections of the body successively encountered as one proceeds from head to foot. Studies were done on 17 patients who had received orally or parenterally for diagnostic or therapeutic purposes in doses from 40 microcuries to 98 millicuries one of the following radioisotopes: Ar^{74}, colloidal gold Au^{198}, Cr^{51} labeled red cells, Cu^{64}, Fe^{59}, P^{32}, Yt^{90}, I^{131}, I^{131} human serum albumin, I^{131} diodrast, and I^{131} Rose Bengal.

In a graph made immediately after the administration of the radioisotope the area under the linear record can be considered as a measure of the administered dose. Repeated scans made at later intervals indicate shifts of the radioactivity within body compartments; the areas under the contours can be used as an index of the total amount of retention. The data can be used for calculation of total-body irradiation dose and sometimes for dose to a particular area or organ.

In patients with internal radioisotope contamination, the scanner (used with spectrometry) will locate and sometimes lead to clear identification of the radioisotope involved.

67. *The ORINS Linear Scanner in Diagnosis and Treatment of Thyroid Carcinoma with I^{131}.* Felix J. Pircher, Beecher W. Sitterson, and Gould A. Andrews, (Medical Division, Oak Ridge Institute of Nuclear Studies).

The ORINS linear scanner was designed by Dr. Marshall Brucer for whole-body scanning and represents an elaboration on the earlier instrument by Dr. E. E. Pochin. The instrument has a long narrow area of sensitivity that is oriented transverse to the body axis. By moving the body under it at a uniform speed, it is possible to obtain a graph or profile which denotes the location and approximately the amount of radioactivity in relation to the long axis of the body. Linear scans were made in 20 patients with carcinoma of the thyroid after the administration of I^{131} for diagnostic and therapeutic purposes in doses of from 0.5 to 160 millicuries. Results: (1) Patients with functioning thyroid carcinoma can be screened for metastases. This requires only 10 minutes spent under the instrument at an appropriate time after the test dose is given. (2) Some degree of quantitation can be made on the isotope in a metastasis and this can be expressed in comparison with a standard or as a percentage of whole-body activity. Results can be used to calculate radiation dose and effective half-life for metastatic lesions and the whole body.

68. *Radioactive Iodine in the Management of Thyroid Cancer: A Review of 63 Patients Treated With I^{131}.* Raymond G. Rose and Mavis P. Kelsey, (The University of Texas M. D. Anderson Hospital and Tumor Institute and The University of Texas Postgraduate School of Medicine, Houston).

Radioiodine therapy has been a major factor in the treatment of 63 patients with thyroid cancer at The University of Texas M. D. Anderson Hospital and Tumor Institute; this represents approximately 20 percent of the total number of thyroid cancer patients seen. Radioiodine has been used in the following situations:

1. To destroy residual tissue in the neck
   a. residual thyroid tissue, presence or absence of residual cancer tissue uncertain—19 cases
   b. residual inoperable cancer known to remain in the neck—16 cases
2. To destroy tumor in the nodes of the neck or mediastinum—11 cases
3. To destroy distant metastases
   a. lung—9 cases
   b. bone—5 cases

The period of follow-up has extended from one to eleven years after I^{131} therapy; in view of this relatively short period, no categorical statements can be made regarding "cure". Response to therapy has been correlated both with site of disease and with tumor histology. Sixty per cent of patients with a papillary, a mixed papillary and follicular pattern, or with a predominately solid pattern and 50 percent of patients with a pure follicular picture are alive with no evidence of recurrent or persistent disease. Of the 19 patients receiving I^{131} for thyroid gland ablation, all are alive, apparently free of cancer. Sixteen patients were treated for known residual cancer in the neck; ten are apparently now free of disease, two patients have had recurrence. Eight of the eleven patients treated primarily for tumor in nodes of the neck and mediastinum have shown no recurrence to date. Of the nine patients with lung metastases, five have had radiographic disappearance of the lesions and three have had long-term palliation with regression or arrest of the lesions. In five cases with metastases to bone, three have had relief of pain and recalcification of the lesions. Eight patients in the entire series have expired, mostly within one year after I^{131} therapy.

The value of thyroid ablation and stimulation procedures (anti-thyroid drugs and T.S.H.) is indicated by a high incidence of induction of, or increase in, tumor uptake of radioiodine in this series. The criteria for I^{131} therapy, dosage considerations and complications are also discussed; the diagnostic importance of careful scanning procedures is emphasized and illustrated by representative cases.

69. *Control of Radiation Quality and Field Size at the Treatment Port of the Medical Research Reactor.* **J. S. Robertson, E. E. Stickley and R. W. Powell, (Medical Research Center Brookhaven National Laboratory, Upton, L.I., New York).**

Radiation dose measurements made at the patient and animal treatment ports of the BNL Medical Research Reactor indicated that the original exposure conditions provided a less than optimal ratio of thermal neutrons to fast neutrons and gamma rays. Rearrangement of the pattern of fuel elements in the reactor core gave essentially no change in the quality of the radiation delivered at the treatment ports. Improvement was achieved, however, by modifying the moderating and filtering elements within the reactor shield and shutter. The principal changes were the substitutions of eight inches of D_2O in the shutter for the original 5¾ inches of D_2O originally in the moderator, and the addition of 5 inches of bismuth in the shutter, bringing the total bismuth in the neutron beam path to 13½ inches and improving the geometry. Further changes were directed toward reducing the gamma leakage through the shield around the treatment ports. Additional control of the exposure area and depth is provided by appropriate aperture fittings contrived from materials selected to reflect or capture neutrons and to absorb gamma rays. The final cross-sectional area of the treatment port can be varied from an opening as large as 10 inches square to as small as may be desired. Extensive measurements of the neutron beam quality are currently under way. These measurements are to be correlated with the observed biological effects.

70. *The Basic Detector.* D. A. Ross, (Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge).

A simple demonstration will be offered, designed to emphasize the basic principle that *disintegration rate* is one thing, whereas *count rate*—although related to it—is something else. A quantitative count is valid only if the two are proportional. The factors bearing on the relationship are presented in simple terms.

71. *Cellular Proliferation Studies Using Tritiated Thymidine.* Joseph R. Rubini, Eugene P. Cronkite, and Victor P. Bond, (Veterans Administration Hospital and Southwestern Medical School, Dallas, and Brookhaven National Laboratory, Upton, L.I., N. Y.).

The recent availability of high specific activity tritiated thymidine, H^3TDR, has made possible new studies of cellular proliferation in man and animals. This tritium labelled pyrimidine deoxyriboside is incorporated into new DNA of proliferating cells both *in vivo* and *in vitro*. Labelled cells are readily detected with high resolution by microautoradiographic techniques.

Serial studies of labelled marrow cell populations have been made in two patients with normal hematopoiesis following intravenous H^3TDR injection. These *in vivo* studies have yielded new information on the dynamics of hemopoietic cell turnover.

In vitro incubation of fresh tissues and tumors with H^3TDR permits estimates of their proliferative potential to be made by determining the per cent labelled cells of a population. This labelling index was determined for various human tumors, tissues and peripheral blood leukocytes. The technique of cell labelling will be presented and some results discussed.

72. *On the Method of Expressing Blood Levels in Gastrointestinal Absorption Studies.* Aaron P. Sanders, Joseph M. James, Kathryn W. Sharpe, and George J. Baylin, (Radioisotope Laboratory, Department of Radiology, Duke University Medical Center, Durham, North Carolina).

Two most commonly used methods of reporting blood levels in the radioiodinated fat absorption studies are 1) where the blood content is expressed as a percent of the ingested dose per total blood volume, and 2) where the blood content is expressed as percent of ingested dose per liter of blood. A statistical analysis of the data from 231 normal subjects who had I^{131} labeled fat absorption studies, with the technique described by Baylin, et al was made. Both methods for recording blood content were analyzed and linear regressions calculated.

It was found that there is an inverse relationship between blood concentration (percent per liter) and body weight of the subject. The average 45 Kg subject shows a blood concentration of 177 percent of that of the average 95 Kg subject at the fourth hour. However, when the blood content is expressed as percent of total blood volume, there is no correlation between total blood content and body weight. The statistical limits of normal when expressing the data as percent per total blood volume is smaller than when expressing the data as percent per liter of blood.

The authors will give the details of the method of study, the statistical analysis, and possible implications.

73. *A Simplified Method for Qualitative Determination of Thyro-Binding Power of Plasma or Serum.* John F. Scholer, (Palo Alto Medical Clinic, Palo Alto, California).

An anion exchange resin is labeled by the addition of radioactive tri-iodothyronine (T3) to resin in distilled water. After washing and drying at room temperature, approximately 0.1 gram portions of this resin are placed in test tubes and the radioactivity determined. At

any time within three weeks, 2 ml of plasma is added to each tube and incubated at 37° for 2 hours. After centrifugation, 1 ml of plasma is withdrawn and its radioactivity measured. The percentage of the original total activity on the resin which is recovered in the plasma is proportional to the Thyro-Binding Power (TBP) of the plasma. Each determination is compared to a similar determination on a "standard" pooled plasma, and the binding power is expressed as an index in which the binding power of the standard is one unit.

The TBP of the plasma as determined by this method has been compared to the values obtained in the "in vitro red blood cell uptake of labeled T3" in more than 400 individuals. The results show a good inverse correlation between the two methods. The plasma of hyperthyroid individuals consistently shows a lowered binding power, that of hypothyroid or pregnant individuals an increased binding power, and both can be satisfactorily distinguished from the plasma of euthyroid individuals. The binding power of serum is regularly less than that of plasma, but the test distinguishes between the sera of pregnant, normal, and hyperthyroid individuals. Although these studies were done using I^{131} labeled tri-idothyronine, preliminary studies indicate that I^{131} labeled thyroxin may be used in a similar fashion.

74. *Factors Influencing the Area and Transit Time of a Time Activity Curve When Used to Measure Cardiac Output and Peripheral Blood Flow.* **Gunnar Sevelius and Philip C. Johnson, (Veterans Administration Hospital and Department of Medicine, University of Oklahoma School of Medicine, Oklahoma City).**

The factors involved in surface counting technique for measuring cardiac output and coronary blood flow have been analyzed by the construction of a model circulation which allows one to reproducibly change one or all of the following components of fluid flow: monitored volume (V), size of injected dose (I), linear speed of flow (S), volume of flow (F), and dilution of the bolus (D). In this way their effect on the area and on the transit time of the bolus as measured by the time activity curve in the peripheral circulations can be estimated. It is shown that the curve area is proportional to I x V and inversely proportional to F. The transit time, as measured by the curve is proportional to I x V x D and inversely proportional to F x S. These proportionalities prove the correctness of the cardiac output formula and the ratio formula used for measuring branched flow.

75. *Literature Available for Teaching.* **Joseph Sternberg, (Institute of Microbiology and Hygiene, University of Montreal, Montreal).**

76. *Measurement of Gastric Emptying Rates in The Dog with Iridium-192 Labeled Resin Suspension and External Counting.* **Erwin Syphers, Ralph Adams, and Ivor Woodward, (Nuclear Medicine Division, Department of Radiology, The College of Medical Evangelists School of Medicine, Los Angeles).**

The effect of operative procedures on the gastric emptying rate of the dog has been studied with a suspension of Ir^{192} labeled resin and an external scintillation detector. A heavy lead shield with an adjustable window and sliding fluoroscopic screen is described for the detection of stomach activity while shielding the small bowel. Analyzer adjustment for optimum sensitivity and reduction of scatter effects is discussed. The reliability of the method and correction for scatter from the small bowel have been evaluated by study of a model. The effects of surgical procedures are summarized.

77. *Liver Blood Flow in Hepatobiliary Disease: Tracer Studies with Radiogold and Rose Bengal.* **G. V. Taplin, J. Hayashi, D. E. Johnson, and E. Dore, (University of California at Los Angeles, School of Medicine, Departments of Biophysics-Nuclear Medicine, Radiology and Medicine, and the Los Angeles County Harbor General Hospital, Torrance, California).**

Until recently, clinical methods for estimating liver blood flow have been technically difficult and not widely applied because they require hepatic vein catheterization. Therefore, little is known about the extent to which liver vascular impairment affects polygonal cell functions. Such information is necessary to evaluate the functional status of the liver particularly in cirrhosis. The blood disappearance rates (T ½ values) of intravenously injected Colloidal Gold^{198} and of Rose Bengal^{131} provide useful indices of liver blood flow and polygonal cell function respectively, and thereby allow one to correlate functional abnormalities with vascular defects.

Radiogold and Rose Bengal tests have ben conducted in more than one hundred patients, simultaneously with a battery of standard liver tests. The findings show that gross reductions of liver blood flow occur mainly in portal cirrhosis and not with severe jaundice from acute hepatitis or biliary obstruction. In cirrhosis, vascular impairment and cellular damage vary almost directly with the severity of the disease; whereas in the acute hepatidides and in biliary tract obstruction, the blood flow measurements usually remain in the normal range and have no correlation with tests for liver cell function. Thus in cirrhotic patients with concurrent hepatitis, one can evaluate vascular and cellular abnormalities separately and determine when the hepatitis has subsided by repeated testing with Gold and Rose Bengal. This study also demonstrates that the Colloidal Radiogold test has diagnostic value in the differential diagnosis of severe jaundice, of ascites of unknown origin and of acute gastrointestinal tract hemorrhage.

78. *Preparation and Use of I^{131} Labeled Bromsulphalein in Liver Function Testing.* **Manuel Tubis, Robert A. Nordyke, and William H. Blahd, (Radioisotope Service, Veterans Administration Center, Los Angeles).**

I^{131} labeled BSP has been prepared (by two methods) to yield a dye of high specific activity having essentially unchanged properties of the original substance. Preliminary data in animal and human subjects demonstrated that it is removed rapidly from the blood and excreted via the liver and biliary tract. Less than 0.5 percent of the intravenously injected activity appears in the urine of non-jaundiced patients. Studies are in progress comparing I^{131} labeled BSP with I^{131} labeled Rose Bengal. Fundamental advantages of the I^{131} BSP are that very small quantities of the dye can be used, radioactivity rather than color provides the desired data and the I^{131} label can be used advantageously to study the metabolism of the dye.

79. *The Use of Co^{57} Labeled Vitamin B_{12} in the Differential Diagnosis of Macrocytic Anemias.* **Joseph B. Workman, and Edward Rusche, (The Radioisotope Laboratory, Department of Medicine, University of Maryland School of Medicine and University Hospital, Baltimore).**

The use of radiocyanocobalamin for the differential diagnosis of macrocytic anemias, is now well established. A number of methods are available for the determination of the intestinal absorption of the labeled vitamin, the most popular, the urinary excretion method of Schilling. The fact that a complete 24 hour urine collection is essential for the proper performance of the Schilling test and the difficulties inherent in achieving such collection in the elderly, has resulted in modifications of the test as well as in investigation of other isotopes of Cobalt as a test material. It would appear that one answer to the urinary excretion problems would be the determination of blood levels of labeled material and so it was. Unfortunately, there were greater problems created when the necessary 1 to 2μc amounts of Co^{60} with its 5 year half-life were given for the determination of blood levels. Another isotope of Cobalt,

Co^{58} has demonstrated that blood levels of radioactivity could be obtained using between 1 and 2 μc of activity. Despite, or in spite of the relatively short 70 day half-life for Co^{58}, the retail cost of the material, which is almost twice that of Co^{60}, makes it routine use, somewhat impractical.

With the advent of another isotope of Cobalt, Co^{57}, with its 270 day half-life and its low energy gamma emission, 0.123 MEV, creating detectable blood levels in many patients with dosages as small as 0.27 μc of Co^{57} and 0.46 μgm of B_{12}, perhaps the answer has been found. The cost of this material is about the same as that of a similar amount of Co^{60}. A medical spectrometer is necessary for the efficient counting of this energy gamma, however.

The results of a variety of patients in whom blood and/or urinary excretion have been done will be presented.

ORGANIZATIONAL

The Seventh Annual Meeting

A review of the scientific program for the seventh annual meeting of The Society of Nuclear Medicine suggests that this may very well be the best program that The Society has so far presented. It covers a wide field, both in the clinical use of radioisotopes and in the applications of these unique tools to the problems of research.

One of the special features of the program will be the Ernest O. Lawrence Memorial Lecture by Dr. Edward Teller, Director of the Lawrence Radiation Laboratory of the University of California, Livermore. This will be the First Annual Address in the Nuclear Pioneers Series. It is believed these lectures will become a tradition of The Society. It would not be possible to find a more eminent speaker than Dr. Teller or one more able to initiate a series which may carry on for many years.

Another item of great interest will be the Thursday night session on the literature, the instrumentation and the teaching methods as these apply to the great new fields represented by The Society of Nuclear Medicine. This session has been prepared by Dr. Marshall Brucer and Dr. Joseph Sternberg. Eight speakers will take part in this symposium.

Guest Speaker

ERNEST O. LAWRENCE MEMORIAL LECTURE

EDWARD TELLER, PH.D.

Director, Lawrence Radiation Laboratory
University of California, Livermore

The Society of Nuclear Medicine
Seventh Annual Meeting
Estes Park, Colorado
Scientific Program

WEDNESDAY, JUNE 22, 1960

1:00 P.M. Executive Committee Meeting.
6:00 P.M. Executive Committee and Board of Trustees Dinner.
7:00 P.M. Executive Committee and Board of Trustees Meeting.

THURSDAY, JUNE 23, 1960

Morning Sessions

9:00 Formal Opening and Welcome—HENRY H. TURNER, President, The Society of Nuclear Medicine, Oklahoma City. (After opening remarks, registrants will have approximately 15 minutes to arrive at the concurrent scientific sessions.)

Session A—THYROID SYMPOSIUM

Coordinator and Chairman: EDWARD A. CARR, JR., University of Michigan, Ann Arbor

9:30 A Binding Coefficient Proposed as an Index of Thyroid Function in the Labeling of Red Cells in Vitro.
RALPH ADAMS, College of Medical Evangelists School of Medicine, Los Angeles

9:45 Discussion

9:50 On the Nature of Radioactive Iodinated Amino-Acids on Thyroid Nodules and Normal Thyroid Tissues.
HERBERT C. ALLEN, JR., JAMES A. CHAMBERLIN, Methodist Hospital, Houston

10:05 Discussion

10:10 Thyroid Stimulation and Suppression Tests.
C. T. KNORPP, M. H. RENNIE, D. R. KORST, Veterans Administration Hospital, Ann Arbor

10.25 Discussion

10:30 Coffee Break

10:50 Radioiodine, I^{125}.
WILLIAM G. MYERS and HAN C. VANDERLEEDEN, Ohio State University Health Center, Columbus

11:05 Discussion

11:10 Whole Body Retention of I^{131} as a Means of Appraising Human Thyroid Function.
C. C. LUSBAUGH, D. B. HALE, and P. S. NEW, Los Alamos Scientific Laboratory, Los Alamos, New Mexico

11:25 Discussion

11:30 Apparent Acceleration of Leukemic Process Following I^{131} Therapy of Hyperthyroidism.
RICHARD E. PETERSON, Veterans Administration Hospital, Iowa City

11:45 Discussion

Session B—SYMPOSIUM ON THERAPEUTIC USES OF RADIOISOTOPES

Coordinator and Chairman: PAUL M. MEADOWS, University of Pittsburgh School of Medicine, Pittsburgh

9:30 The Treatment of Inoperable Lung Cancer by Combined Radioisotopes.
IRVING M. ARIEL, New York

9:55 Summary of Nine Years of the Use of Radioactive Colloids in Intracavitary Injection.
R. Y. CARD, D. COLE, and U. HENSCHKE, St. Mary's Hospital, Salt Lake City

10:20 Therapy of Polycythemia Vera with Radioyttrium (Y^{90}).
JOSEPH GREENBERG, ARTHUR SAWITSKY, H. C. DUDLEY, ROBERT LEVY, and KANTI R. RAI, Long Island Jewish Hospital, New Hyde Park, New York

10:45 Coffee Break

11:05 The ORINS Linear Scanner in Diagnosis and Treatment of Thyroid Carcinoma with $Iodine^{131}$.
FELIX J. PIRCHER, BEECHER W. SITTERSON, and GOULD A. ANDREWS, University of Michigan Hospital, Ann Arbor, and Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge

11:30 Radioactive Iodine in the Management of Thyroid Cancer—A Review of 63 Patients Treated with I^{131}.
RAYMOND G. ROSE and MAVIS P. KELSEY, the M. D. Anderson Hospital, Houston

12:00 Intermission for Lunch and Exhibit Viewing

Afternoon Session—SYMPOSIUM ON SCANNING

Coordinator and Chairman: MERRILL A. BENDER, Roswell Park Memorial Institute, Buffalo

2:30 A Theoretical Evaluation of Brain Scanning Systems.
ROBERT N. BECK, Argonne Cancer Research Hospital, Chicago

2:40 Discussion

2:45 A Focusing Collimator for Research in Scanning.
J. E. FRANCIS, C. C. HARRIS, and P. R. BELL, Oak Ridge National Laboratory, Oak Ridge

2:55 Discussion

3:00 The Use of a Photocopying Process for Erasing the Background of Photoscans Representing a Radioactive Target Region Located Inside a Large Nontarget Region.
WILLIAM C. DEWEY and JOAN G. CUNNINGHAM, The M. D. Anderson Hospital, Houston

3:10 Discussion

3:15 Recent Advances in Scanning Equipment.
C. C. HARRIS, J. E. FRANCIS, JR., P. R. BELL, D. P. HAMBLEN, and H. O. EASON, Oak Ridge National Laboratory, Oak Ridge

3:25 Discussion

3:30 The ORINS Linear Scanner in Clinical Diagnosis.
FELIX J. PIRCHER, MARSHALL BRUCER, A. C. MORRIS, JR., RUTH BLACK, University of Michigan, Ann Arbor, and Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge

3:40 Discussion

3:45 Coffee Break

4:00 A Total Body Scanner.
H. E. JOHNS, J. CEDERLUND, and D. ROTENBERG, Ontario Cancer Institute, Toronto

4:10 Discussion

4:15 Autofluoroscopy—The Use of a Non-Scanning Device for Tumor Localization with Radioisotopes.
MERRILL A. BENDER and MONTE BLAU, Roswell Park Memorial Institute, Buffalo

4:25 Discussion

4:30 A Comparison of I^{131} Rose Bengal and Colloidal $Gold^{198}$ in Liver Scanning.
GODOFREDO CRESPO, WILLIAM J. MACINTYRE, and JAMES H. CHRISTIE, Highland View Hospital, Cleveland

4:40 Discussion

4:45 Experimental Studies for Scintillation Scanning of the Pancreas.
ROBERT H. GREENLAW and WILLIAM H. STRAIN, University of Rochester Medical Center, Rochester

4:55 Discussion

5:00 Clinical Evaluation of Hg^{203} Neohydrin and I^{131} Albumin in Brain Tumor Localization.
MONTE BLAU and MERRILL A. BENDER, Roswell Park Memorial Institute, Buffalo

5:10 Discussion

5:15 An Appraisal of As^{74} for Localization of Brain Tumors.
W. PAUL and E. H. BOTTERELL, Pathology, Chemistry, and Surgical Departments, University of Toronto, Toronto

5:25 Discussion

Evening Session—TEACHING SYMPOSIUM ON TOOLS OF THE TRADE IN NUCLEAR MEDICINE

Co-Chairmen and Coordinators: MARSHALL BRUCER and JOSEPH STERNBERG, Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge, and Institute of Microbiology and Hygiene, University of Montreal, Montreal

8:00 "What Are the Tools of the Trade in Teaching and Training of Nuclear Medicine?"
JOSEPH STERNBERG, Institute of Microbiology and Hygiene, University of Montreal, Montreal

8:10 Present Situation in the Printed Information in Nuclear Medicine.
HERBERT VETTER, Section of Medicine, Department of Research and Isotopes, International Atomic Energy Agency, Vienna, Austria

8:22 Training Aids.
RALPH M. KNISELEY, Eden Hospital, Castro Valley, California

8:35 Goldfish and Yeast Experiments.
GRANVIL C. KYKER and FRED SNYDER, Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge

8:45 A Half-Life Demonstrator.
RAYMOND HAYES, Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge

8:55 ORINS Electronic Breadboard.
A. C. MORRIS, JR., Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge

9:05 Isoresponse Studies.
MARSHALL BRUCER, Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge

9:15 The Basic Detector.
D. A. Ross, Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge

9:25 The Statisticator.
MARSHALL BRUCER, Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge

FRIDAY, JUNE 24, 1960

Morning Sessions

Session A

Presiding: ROBERT E. ZIPF, Miami Valley Hospital, Dayton

8:30 Three Years of Experience in the Therapeutic Use of Radioactive Gold Grains.
ROBERT J. DICKSON, Johns Hopkins Hospital, Baltimore

8:45 Radiostrontium—87 m.
WILLIAM G. MYERS, Ohio State University Health Center, Columbus

9:00 Liver Blood Flow in Hepatobiliary Disease—Tracer Studies with Radiogold and Rose Bengal.
G. V. TAPLIN, J. HAYASHI, D. E. JOHNSON, and E. DORE, University of California Medical Center, Los Angeles

9:15 Solid-State Dosimetry.
CHARLES G. AMATO, S. J. MALSKY, and B. ROSWIT, Brookhaven National Laboratory, Upton, New York

9:30 Control of Radiation Quality and Field Size at the Treatment Port of the Medical Research Reactor.
J. S. ROBERTSON, E. E. STICKLEY, and R. W. POWELL, Brookhaven National Laboratory, Upton, New York

9:45 A Radioisotope Concentration Gradient Analyzer for Determination of Electrophoretic Mobilities and Sedimentation Velocities of Labeled Proteins.
SOLOMON A. BERSON and ROSALYN S. YALOW, V. A. Hospital, Bronx, New York

10:00 Coffee Break

10:30 Practical Application of Neutron Activation Analysis for the Determination of Protein Bound Metals in Blood Serum.
A. JACOBSON, S. BRAR, T. FIELDS, I. G. FELS, E. KAPLAN, P. GUSTAFSON, and Y. T. OESTER, V. A. Hospital, Hines, Illinois, and Argonne National Laboratory, Lemont, Illinois

10:45 Total Exchangeable Potassium Determination in Saliva.
FRANZ K. BAUER, NANCY TELFER, JUANITA LESTINA, and MARVA JENKINS, University of Southern California and Los Angeles County Hospital, Los Angeles

11:00 Measurement of Gastric Emptying Rates in the Dog with Iridium (Ir^{192}) Labeled Resin Suspension and External Counting.
ERWIN SYPHERS, RALPH ADAMS, and IVOR WOODWARD, College of Medical Evangelists School of Medicine, Los Angeles

11:15 Exchangeable Sodium and Potassium in Primary Aldosteronism.
M. G. CRANE, J. J. HARRIS, and J. E. HOLLOWAY, College of Medical Evangelists School of Medicine, Los Angeles

11:30 The Accumulation of Radioactive Substances on Glass.
CHARLES J. HLAD, M. ERVIN, and HAROLD ELRICK, Veterans Administration Hospital and General Rose Memorial Hospital, Denver

11:45 Accidental Exposure to Partial Body X-Irradiation.
DAVID I. LIVERMORE, Aerospace Medical Division, Office of Surgeon-General, USAF, Washington, D. C.

Session B

Presiding: John D. Reeves, University of Florida Medical College, Gainesville

8:30 Enhancement of Therapeutic Effectiveness of P^{32} Labeled Polymetaphosphate by Oral Estrogens in Carcinoma of Prostate Metastatic to Bone.
E. KAPLAN, I. G. FELS, and J. J. IMARISIO, Veterans Administration Hospital, Hines, Illinois

8:45 Bile, An Inhibitor of Vitamin B_{12} Absorption.
W. L. HONSKA, T. B. DRISCOLL, and P. C. JOHNSON, Veterans Administration Hospital, Hines, Illinois

9:00 Preparation and Use of I^{131} Labeled Bromsulphalein in Liver Function Testing.
MANUAL TUBIS, ROBERT A. NORDYKE, and W. H. BLAHD, Veterans Administration Center, Los Angeles

9:15 Endocrine Binding of Radio-Cobalamine.
HENRY LANZ and JOSEPH R. RUBINI, Veterans Administration Hospital, Dallas

9:30 A Simplified Method for the Qualitative Determination of Thyro-Binding Power of Plasma or Serum.
JOHN F. SCHOLER, Palo Alto Medical Clinic, Palo Alto, California

9:45 Clinical Value of the Plasma-Iron Turnover Rate in the Diagnosis and Treatment of Polycythemia.
JOSEPH M. KIELY, CHARLES F. STROEBEL, DAVID G. HANLON, and CHARLES A. OWEN, JR., Mayo Clinic and Foundation, Rochester, Minnesota

10:00 Coffee Break

10:30 The Clinical Importance of Erythrocyte and Plasma Volume Determination Before and After Open-Heart Surgery.
EDWARD A. CARR, JR., HERBERT E. SLOAN, and ENRIQUE TOVAR, University of Michigan Medical Center, Ann Arbor

10:45 The Use of Co^{57} Labeled Vitamin B_{12} in the Differential Diagnosis of Macrocytic Anemias.
JOSEPH B. WORKMAN and EDWARD RUSCHE, University of Maryland School of Medicine and University Hospital, Baltimore

11:00 Anemia of Nontropical Sprue Studied with Radioiron and Radiochromium.
EMILIO R. GIULIANI, ALBERT B. HAGEDORN, CHARLES A. OWEN, JR., and HAROLD H. SCUDAMORE, Mayo Clinic, Rochester, Minnesota

11:15 Neutron Capture Therapy of a Cerebellar Hemangiosarcoma Following Surgical and Radiological Treatment.
LEE E. FARR and LUCAS Y. YAMAMOTO, Brookhaven National Laboratory, Upton, New York

11:30 The Influence of Estradiol on "Apparent" Phosphotidycholine Synthesis in Sprague Dawley Rats.
E. N. BOWSER, W. HENDERSON, and H. J. ZIMMERMAN, Veterans Administration West Side Hospital, Chicago

11:45 Neutron Spectroscopy as Applied to the Brookhaven Medical Research Reactor.
CHARLES G. AMATO, Brookhaven National Laboratory, Upton, New York

12:00 Intermission for Lunch and Exhibit Viewing

Afternoon Sessions—FIRST ANNUAL ADDRESS IN THE NUCLEAR PIONEERS SERIES

(Open to All Registrants and Guests)

2:00 *Presiding:* J. R. MAXFIELD, JR., Dallas
Introduction: JOHN H. LAWRENCE, Donner Laboratory, University of California, Berkeley
ERNEST O. LAWRENCE MEMORIAL LECTURE: EDWARD TELLER, Guest Speaker, Lawrence Radiation Laboratory, University of California, Livermore

SYMPOSIUM ON TOTAL BODY RADIATION

Coordinator and Moderator: VINCENT P. COLLINS, Baylor University College of Medicine, Houston

3:30 Low Dose Effects of Total Body Irradiation As Observed in Clinical Use of Total Body Irradiation.
VINCENT P. COLLINS, Baylor University College of Medicine, Houston

3:40 High Dose Effects of Total Body Irradiation As Observed in Accidental Exposures and Attempted Repression of Immune Response.
RALPH KNISELEY, Eden Hospital, Castro Valley, California

4:00 Dosimetry of Total Body Radiation.
(a) Physical Dosimetry.
A. C. MORRIS, Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge
(b) Chemical Dosimetry.
RAYMOND L. HAYES, Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge

4:05 Evaluation and Management of the Heavily Irradiated Individual.
VICTOR P. BOND, Division of Microbiology, Medical Research Center, Brookhaven National Laboratory, Upton, N.Y.

4:45 Business Meeting
Installation of Officers

SATURDAY, JUNE 25, 1960

Morning Sessions

Session A

Presiding: DAVID LIVERMORE, Aerospace Medical Division, Office of the Surgeon General, USAF, Washington, D. C.

8:30 A New Approach to the Measurement of Body Fluid Constituents—Determination of Plasma Sulfate Using Radioactive Barium (Ba^{133}).

E. MILLER, C. J. HLAD, J. H. HOLMES, and H. ELRICK, Veterans Administration Hospital and University of Colorado Medical School, Denver

8:45 Use of Intravenous Radioactive Fat Emulsion in the Study of Lipid Metabolism.

DONALD BERKOWITZ and DAVID M. SKLAROFF, Albert Einstein Medical Center, Philadelphia

9:00 Evaluation of Portal Circulation by the Use of Precutaneous Splenic Isotope Injection.

ROBERT H. GREENLAW and SEYMOUR I. SCHWARTZ, University of Rochester Medical Center, Rochester, New York

9:15 The Use of Radio-Cholografin in Cardiovascular Studies.

WILLIAM J. MACINTYRE, GODOFREDO CRESPO, and JAMES H. CHRISTIE, Highland View Hospital, Cleveland

9:30 Factors Influencing the Area and Transit Time of a Time Activity Curve When Used to Measure Cardiac Output and Peripheral Blood Flow.

GUNNAR SEVELIUS and PHILIP C. JOHNSON, V. A. Hospital and University of Oklahoma Medical School, Oklahoma City

9:45 Coffee Break

10:15 Effects of Localized Doses of High Intensity X-irradiation on the Cardiovascular System of the Rat.

R. BARATZ, W. S. MOOS, and R. A. HARVEY, University of Illinois College of Medicine, Chicago

10:30 Observations on the Disappearance of Labeled Albumin Injected Intra-Articularly.

STEN JACOBSON, and ARNOLD FELDMAN, University of Colorado Medical Center, Denver

10:45 The Hepatic Removal of Cr^{51} Labeled Endotoxin from the Circulation of the Rabbit.

DIETER KOCH-WESER, WILLIAM J. MACINTYRE, JOHN R. MOSES, and RALPH L. SCHAPIRO, Western Reserve University School of Medicine, Cleveland

11:00 Cellular Proliferation Studies Using Tritiated Thymidine.
JOSEPH R. RUBINI, EUGENE P. CRONKITE, and VICTOR P. BOND, Veterans Administration Hospital and Southwestern Medical School, Dallas, and Brookhaven National Laboratory, Upton, L. I., N. Y.

11:15 On the Method of Expressing Blood Levels in Gastrointestinal Absorption Studies.
AARON P. SANDERS, JOSEPH M. JAMES, KATHRYN W. SHARPE, and GEORGE J. BAYLIN, Duke University Medical Center, Durham, North Carolina.

Session B

Presiding: WYNTON H. CARROLL, Shreveport, Louisiana

8:30 Determination of Radioactivity in a Stool Specimen—A Direct Method Employing a Standard Carton with a Modified Well Counter.
JOHN D. BONNET, NICHOLAS C. HIGHTOWER, JR., and ARNO W. SOMMER, Scott and White Clinic, Temple, Texas

8:45 EDTA-Cr^{51} γ-Ray "Carrier."
WILLIAM G. MYERS and CARL F. DIENER, Ohio State University Health Center, Columbus

9:00 The Radioisotope Renogram—Optimal Equipment, Technics, and Test Agent.
D. E. JOHNSON, G. V. TAPLIN, J. HAYASHI, and E. DORE, University of California Medical Center, Los Angeles

9:15 Analysis of the Diodrast Renogram.
ALVIN S. BLUM, Veterans Administration Hospital, Coral Gables, Florida

9:30 The Radioisotope Renogram—Advances in Procedure.
ROBERT A. NORDYKE, Veterans Administration Center, Los Angeles

9:45 A Body Cross-Section-Scan Phantom for the Study of Scintillation Collimators.
ARTHUR F. DRATZ, JAMES C. COBERLY, and ROBERT H. ROHRER, Veterans Administration Hospital, Atlanta

10:00 Coffee Break

10:15 Radioactive Contour Myelography in Infants.
ROBERT L. BELL, State University of New York, Downstate Medical Center and Kings County Hospital, Brooklyn

10:30 A Device for Safely Milking Carrier-Free Yttrium^{90} from Strontium^{90}.
R. F. DOERING, W. D. TUCKER, L. G. STANG, JR., Brookhaven National Laboratory, Upton, New York

10:45 **An in Vitro Procedure for Screening Intrinsic Factor Concentrates.**
WALTER HENDERSON, NELSON BOWSER, PAUL HELLER, and JOAQUINA GREENE, Veterans Administration West Side Hospital, Chicago

11:00 **Intragastric Beta Radiation Therapy with Radioactive Ruthenium-Rhodium^{106} in Patients with Duodenal Ulcer.**
ARMAND LITTMAN, BENUM W. FOX, and RAYMOND TEPLITZ, University of Illinois College of Medicine, Chicago, and Veterans Administration Hospital, Hines, Illinois

11:15 **Radioisotope Evaluation of the Pulpless Tooth Problem.**
F. JAMES MARSHALL and J. R. TROTT, University of Manitoba School of Dentistry, Winnipeg

Scientific Exhibits

Scintillation and Position Camera

H. O. Anger, University of California, Donner Laboratory and Donner Pavilion, Berkeley, California

Response of Skin Grafts to Radiation Therapy

Robert H. Greenlaw, Dept. of Radiology, Strong Memorial Hospital, Rochester, New York

Aids in Performing Thyroid Function Studies

Walter Henderson and Nelson Bowser, Veterans Administration Hospital, Chicago, Illinois

Miniature Exhibits

Monte Blau
Roswell Park Memorial Institute
Buffalo, New York

Marshall Brucer
ORINS Medical Division
Oak Ridge, Tennessee

Technical Exhibits

Abbott Laboratories
North Chicago, Illinois

Atomation, Inc.
Los Angeles, California

Baird Atomic & Atomic Accessories
Cambridge, Massachusetts

Coulter Electronics
Chicago, Illinois

Curtis Nuclear
Culver City, California

Harshaw Chemical Company
Cleveland, Ohio

Nuclear-Chicago Corp.
Des Plaines, Illinois

Nuclear Consultants Corp.
St. Louis, Missouri

Nuclear Measurements Corp.
Indianapolis, Indiana

Packard Instrument Co.
La Grange, Illinois

Picker X-Ray Corporation
White Plains, New York

E. R. Squibb & Sons
New York, New York

Tracerlab, Inc.
Waltham, Massachusetts

Volk Radiochemical Company
Chicago, Illinois

The Society of Nuclear Medicine
Seventh Annual Meeting

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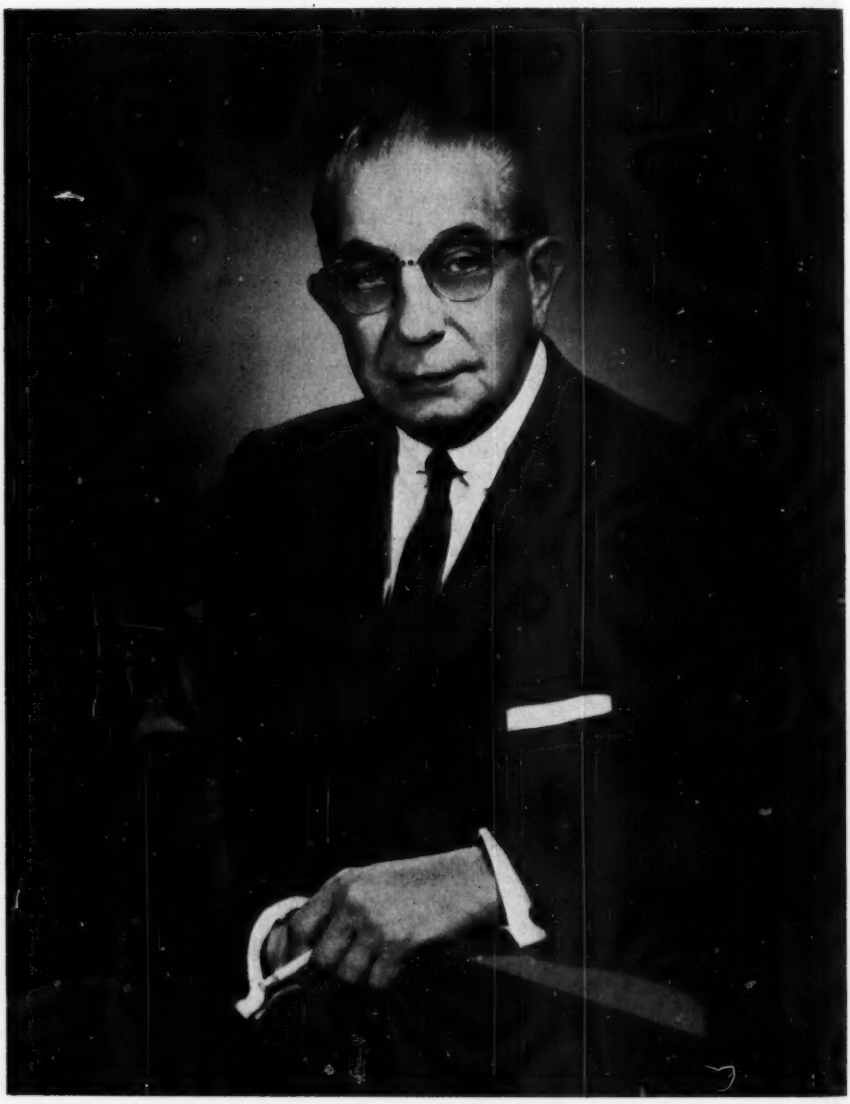

HENRY H. TURNER, M.D.
President 1959-1960

President's Annual Report

One of the distinct privileges to be exercised by the outgoing president of any organization is the opportunity to address the membership both in person and in the Society's official publication.

It has been an honor to serve as the President of The Society of Nuclear Medicine during the past year and to participate in the growth of our Society. The membership of our Society is unique in that it embraces physicians and other members of the health team, all of whom are interested in the utilization of nuclear phenomena in the diagnosis and treatment of disease.

The study and use of radioisotopes have moved from the research centers into clinical centers during the past decade. General Practitioners, as well as all specialists, are now availing themselves of information currently available in the utilization of radioisotopes.

Within the next decade the use of nuclear phenomena will become routine in every branch of medicine, however, due to the nature of radioisotopes, we shall also be in need of men and women such as you not only to find new uses and new techniques, but also to make current procedures safer and more efficient. To make these new techniques, and other important discoveries, available to those engaged in some aspect of nuclear medicine, our Society provides not only the annual and regional meetings for the presentation of such material but has also provided a publication for your use. We sincerely hope our newly established Journal of Nuclear Medicine, under the capable leadership of Dr. George Thoma, will continue to serve the best interests of you and your colleagues.

As the Society grows so will our responsibilities both to our members and to the public at large. At this very moment many of you are undoubtedly being called upon by your State and other municipal organizations to assist in their newly transferred responsibility of preparing codes and regulations concerning the use of radioisotopes.

The Society of Nuclear Medicine has a membership of approximately 1500. Its affairs are carefully supervised by the diligent members of both the Board of Trustees and the Executive Committee to whom I should like to take this opportunity of expressing my sincere appreciation for their cooperation during the past year. A special vote of thanks I extend to my fellow Officers and to the Chairmen of the Society's Standing Committees.

The scientific program for the 7th Annual Meeting, prepared by Dr. J. R. Maxfield, Jr. and his Program Committee, serves as sufficient evidence of the extraordinary program arranged by his hard working committee.

The arrangements for the Annual Meeting involves many hours of work and considerable responsibility. Dr. Thad Sears, Chairman of the Local Arrangement Committee and members of his Committee, truly deserve a standing ovation.

As our membership increases we also find a need for increasing the number of our regional chapters. At the conclusion of last year's meeting a charter was presented to the Eastern Great Lakes Chapter. At this Annual Meeting, it will be my privilege to issue charters to our newly organized Hawaii Chapter and Greater New York City Chapter.

Our other chapters have been most active during the past year presenting exceptional scientific programs and through their officers, participating in the administration of your Society.

To handle the many details in administering the affairs of our Society, we have retained the services of Mr. Sam Turiel, who stands ready to serve you and other members of the Society and to cooperate in every way possible.

Last but not least, it has been you, as members of The Society of Nuclear Medicine by prompt payment of your annual dues; attendance at the annual and regional meetings; preparation of manuscripts for publication in our Journal of Nuclear Medicine; participation in our various committees and in other ways too numerous to mention; who have been responsible for the continued growth and success of our Society.

In conclusion, I want to take this opportunity not only to extend my sincere congratulations to your new President, Dr. Titus C. Evans, but to assure Dr. Evans of our continued support during the coming year.

HENRY H. TURNER, M.D.,
President